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THE POSSIBILITIES OF SALTON SEA

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LOS ANGELES, CAL.

THROUGH temporarily losing control over the Imperial Valley irrigation system in southern California, there has been suggested the possibility of creating an immense inland sea. This sea would extend from Volcano Lake in Mexico to a point a few miles north of Indio, California, and would spread over an area of 1,700 square miles, with a maximum depth of 280 feet. It would be fed by an irrigation canal intersecting the Colorado River near Yuma, Arizona, and its overflow would be carried into the Gulf of California by the lower part of the same river. It would submerge many acres of irrigated and irrigable land, about a dozen fair-sized towns of more or less importance, several miles of the Southern Pacific Railroad, and a number of rich deposits of valuable minerals. And the ability to create such a sea or lake lies simply in abandoning the present effort to regain control over this irrigation system.

Dealing still further with possibilities of this nature, it may be pointed out that the feed canal of this inland sea could be widened and dredged; and thereby could be created a channel sufficient in dimensions for the entry of boats from the Gulf. This would make it possible for coast steamers to ply between ports on the Pacific Coast and a lake port that might be established near the present site of the town of Indio, at the foot of the eastern slope of the Sierra Madre Mountains, and with a latitude almost parallel with the city of Los Angeles. It is true that if the effort now being made to regain control over this rebellious system of irrigation should be abandoned to-day, and nature be permitted to reign supreme and unaided by man, it would be several years before the Colorado River could possibly complete the creation of the lake;

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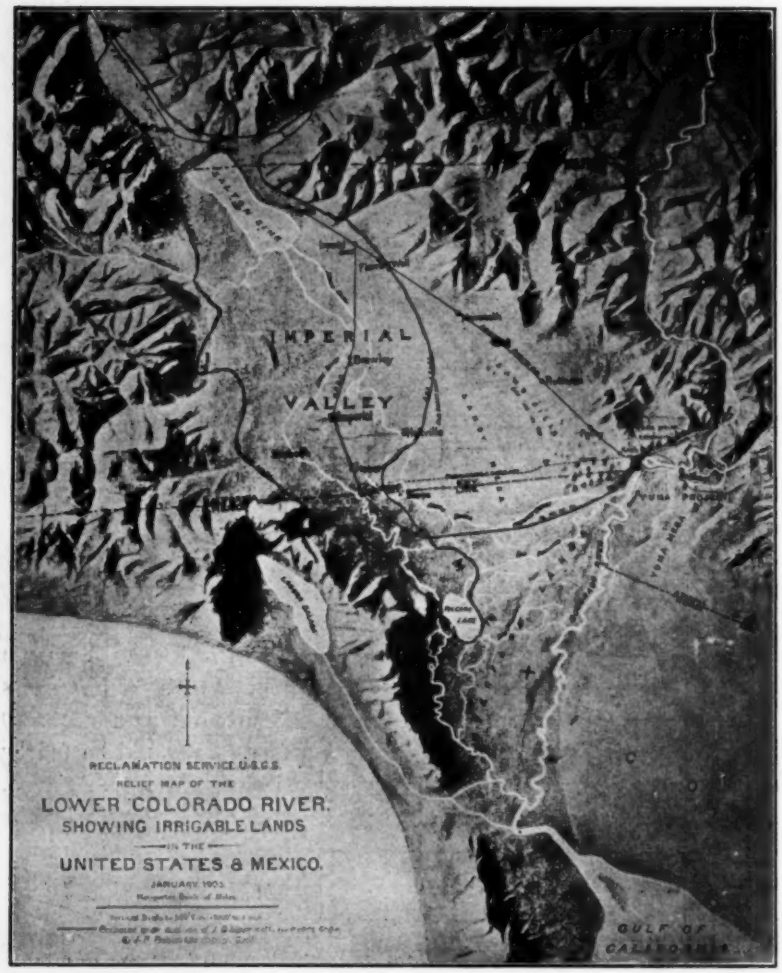


but since all this territory lies beneath the level of the sea, it is even possible for engineers to change the course of the lower part of the river, so that it would carry water from the Gulf of California to assist in the lake's completion. It may be remarked in this connection, however, that there is no probability at present of such a series of possibilities being permitted to materialize. In the light of present considerations, the value of the land and its products far outweighs the possible benefits of such a lake and inland port. Nevertheless it is a matter worthy of consideration.

The Colorado Desert, of which the greater part would be covered by this inland sea, is bounded on the west by the Sierra Madre Mountains, on the north and east by the San Bernardino and Riverside Ranges, and on the east by the Colorado River. As, therefore, would be

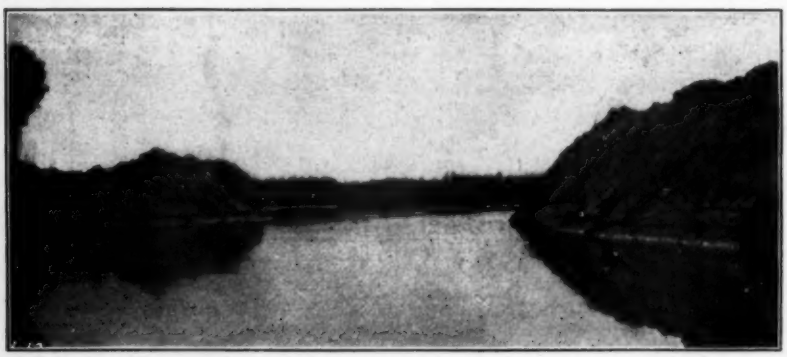
NEW RIVER BELOW ROCKWOOD. January 16, 1904.

MAIN CANAL EAST OF CALEXICO. December 16, 1904.

EXPLORING SALTON SEA FOR THE SOURCE OF THE WATERS. January 13, 1905.

MEXICANS LIVING ALONG CANAL IN MEXICO. January 21, 1905.

INTAKE No. 1, from North Bank. January 22, 1905.



INTAKE No. 3, looking out toward the river. February 15, 1905.

shown in a relief map, it is in the shape of an acute triangle, with its base resting upon the Colorado River, on the east side, and extending northwest and up the Coachella Valley toward Mt. San Jacinto. The land slopes gradually from the river northwest to the Salton Sink, which at the lowest point is 280 feet below sea level. Yuma, Arizona, lies at the northeast corner of this triangle, and is 137 feet above sea level, which, therefore, gives the feed canal, created for irrigating, a fall of 417 feet.

Indio, at the extreme northwest point of the triangle, is 22 feet below sea level, while Volcano Lake, Mexico, is found to be very close to sea level. The town of Indio is the end of a division of the Southern Pacific Railroad, where the company has machine shops and maintains a large force of men. It is also a health resort, and has a fine hotel and sanitarium. The other towns of this sunken area, which would be submerged by such a lake, are: Salton, 265 feet below sea level; Walters, 189; Thermal, 121; Imperial, 65; Alamo Bonito, 186; Coachella, 65; Mortmier, 248; Volcano Spring, 265; Fish Spring, 230, and Mecca, 18.

The town of Imperial, located near the center of the Imperial Valley irrigation colony, is fast becoming a very important little city. Four years ago it was unknown. Its site was only a part of the bare Colorado Desert. An examination of the soil of this vicinity, however, revealed the fact that the only thing necessary to make it productive was water, and in consequence a company was organized to install a system of irrigation. A canal was dug that intersected the Colorado River near Yuma, and by the water thus supplied the region was awakened into life and fertility. As a result, in the past four years, the town of Imperial has come into being, and about 110,000 acres of the surrounding land have been converted into a prospering farming community, with a total population of over 10,000 persons. And the limit has by no means yet been reached, for there is much more of the region in a reclaimable condition.

Up to the time that this irrigation system placed Imperial upon the map, the most important industry on the Colorado Desert was the salt works at Salton. Salton Sink was a vast dry lake of solid salt, and thousands upon thousands of tons of it were mined by simply scraping it up into piles. This industry furnished employment to a large corps of men, and the town of Salton came into being as the result of its being made the headquarters of the New Liverpool Salt Company.

But Salton at present is dead. The town and the works are buried in a grave of water. The person who journeys thither to-day looks upon a vast lake. The homes are deserted, the salt works are abandoned, and Salton Sink, once a dry lake of pure salt, lies transformed

EARTH DAM ACROSS INTAKE NO. 1. May 29, 1905

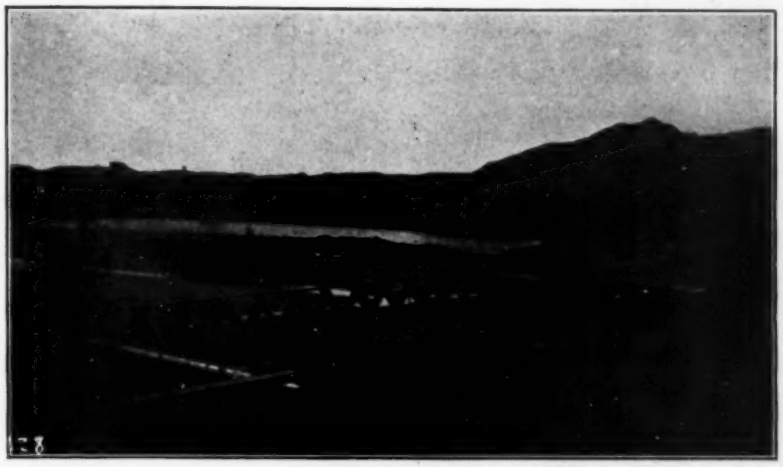
into a billowy sea. Imperial not only became its peer in importance, but its annihilator as well. The savior or the creator of the one became the destroyer and the grave of the other. It was water from the Colorado River that brought Imperial into being, and it was water from the same source that gave Salton its watery burial.

It was not with the spirit of rivalry, however, that Imperial wrought Salton's annihilation. Instead, it is said to have been due to neglect. The main canal for the Imperial Valley irrigation system, which makes use of about fifty miles of what was once the channel of the old Alamo River, draws its water from the Colorado River at a point about ten miles below Yuma, and near the international boundary line between California and Mexico. At this intersecting

VIEW LOOKING SOUTH ACROSS INTAKE NO. 3. May 29, 1905.

point there are three intakes or openings, for each of which there should have been provided a head-gate. This was not done, however, and over a year ago, during high water in the Colorado, these intakes began to admit more water than was necessary for use for irrigation. This surplus, which at times was very large, naturally sought the lowest part of the desert, and in consequence Salton Sink became 'Salton Sea.'

Edwin Duryea, Jr., C. E., of San Francisco, who has made a careful study of the situation for the Southern Pacific Railroad, says that since October, 1904, when the canal first began to carry a surplus, the water in Salton Sink has steadily risen at the average rate of over one half inch per day. At times, during floods, this has even been



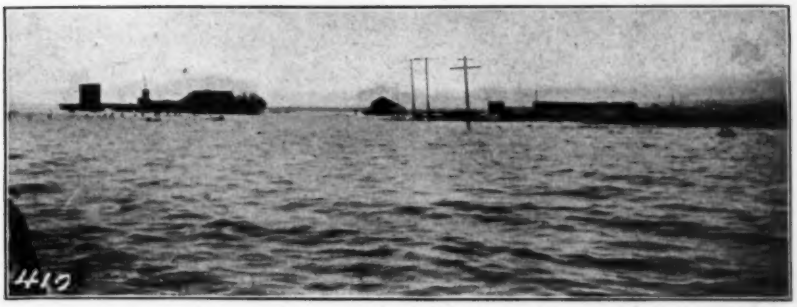
UNUSED HEAD-GATE BETWEEN INTAKES NOS. 1 AND 2. May 29, 1905.

temporarily increased to the rate of two inches per day. The water used by the irrigation system varies with the seasons from nothing in rainy weather to about 1,000 cubic feet per second; and Mr. Duryea, to show the variations in the surplus of water carried into the region, has made a number of measurements that leave no doubt as to the importance of the danger threatened. On February 14, 1905, the canal received 2,500 cubic feet per second, while about 30,000 cubic feet passed down the river; June 5, about 8,000 cubic feet went to the canal per second and 60,000 down the river; July 18, 18,000 to the canal and 7,000 down the river; October 17, 7,000 to the canal and none down the river; November 20, 6,000 to the canal and 128 down the river; December 13, 10,300 to the canal and none down the river. On November 29, there was a flood in the Colorado River, and it was estimated that the river at Yuma carried a maximum flow of 110,000 cubic feet per second, of which about one-half went into the canal, and thence into Salton Sea.

VIEW FROM ISLAND IN RIVER LOOKING NORTH TOWARD THE THIRD ATTEMPT. July 18, 1905.

VIEW LOOKING SOUTH ACROSS INTAKE NO. 3 AND REMAINS OF SECOND ATTEMPT. July 18, 1905.

SAND-BAGS ALONG S. P. TRACK, looking West. July 16, 1905.



S. P. TRACK NEAR SALTON, looking West. October 19, 1905.

The result of this surplus flow, due to the loss of control over the irrigation system, has been the creation of a lake averaging about forty miles in length by ten miles in width, and therefore covering an area of about 400 square miles. The Southern Pacific Railroad has been compelled to build many miles of new road to skirt this embryo lake, and the salt works of the New Liverpool Salt Company are immersed in more than twenty feet of water. This was the condition at the close of the year 1905, and the size of the lake is still increasing.

The first attempt to control this rebellious system of irrigation was made in March, 1905. It was a very frail effort, however, and the construction was washed away before it was entirely finished. Four other attempts followed in almost monthly succession, and each in turn met the same fate as the first. Then came the sixth. It, unlike the former ones, was undertaken on a larger scale and with a fuller realization that the problem to be confronted was a grave one. A large force of men was employed, and the attempt was prosecuted with vigor. Two hundred men, twenty teams, two pile-drivers and two stern-wheel river steamers were employed, and the work was carried on night and day. The intention was to construct a 600-foot dam across the west branch of the river, and thereby control the canal service by diverting the water into the east branch—except at such times and in such quantities as were necessary for irrigation. The dam was made of brush woven into mats and reinforced by several rows of piles. The flood of November 29, however, came before it was finished, entirely covering the work with water and washing it away, and thus destroying the sixth attempt.

But the effect of this failure was only to more thoroughly convince the Southern Pacific Railway Company, which had assumed charge of the work in June, that the canal system must be controlled. The company almost immediately, or in December, 1905, awarded a contract for the seventh attempt, and in January of 1906 work was again commenced.

INTAKE No. 2, looking out toward the river. October 17, 1905.

The seventh attempt was pushed with even greater determination than the sixth. A larger corps of men was employed, and the work was planned upon a more substantial scale. It progressed quite slowly on account of high water at different times, but at last it is finished, and the engineers feel confident that the problem, after a year and a half, is now solved. The gates were declared completed about the middle of July, but on account of the swollen condition of the Colorado River they have not yet been tested. The gate on the California side is constructed to admit 20,000 cubic feet per second, and the present flow of the river is in excess of 30,000 cubic feet per second. As soon as the river goes down to its normal condition the gate will be tested, and the engineers who have managed its construction assert that there is no possibility of its not standing the test.

DETAILS OF SIXTH ATTEMPT, November 20, 1905.

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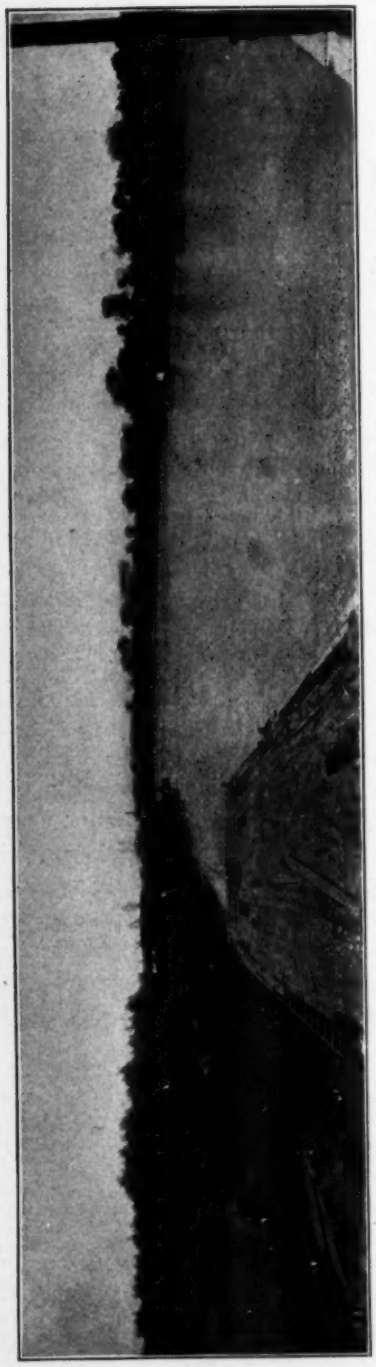
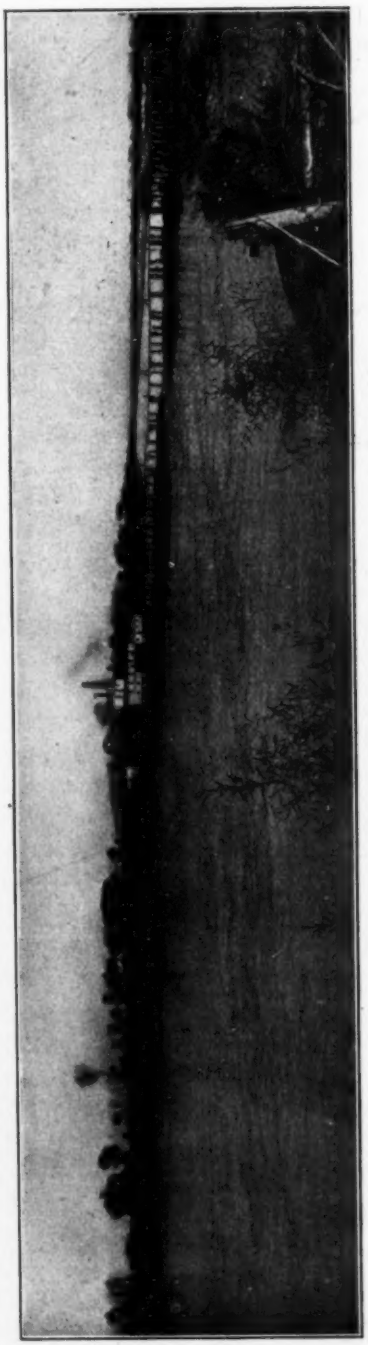
The total cost of the seventh and last attempt to control this irrigation system has been $40,000, or thereabouts. There are two head-gates—one, of concrete, on the California side, and one, of wood, on the Mexico side. The one of concrete is built to stand the greater portion, by far, of the strain, and it has every appearance of being amply substantial. The cost of this gate alone was $24,770.47. It necessitated the excavation of 12,637.1 cubic yards of earth and 5,700.81 cubic feet of rock, and required the use of 1,335 barrels of cement, 1,204.85 cubic yards of sand, gravel and rock, 25,722 pounds of steel bars for reinforcement and 791 pounds of expanded metal for gate facings. The work is being engineered by Mr. C. F. Cory, an engineer of wide repute.

Although these dams or head-gates seem to promise a solution to the Salton Sea problem, there is nevertheless excuse for apprehensions of further trouble. The banks of the Colorado River in this vicinity are soft and gravelly and very easily eroded, and on this account there will always be the possibility of new channels being cut around these head-gates, especially during flood seasons.

DETAILS OF SIXTH ATTEMPT, November 20, 1905.



VIEW DOWN WEST CHANNEL OF COLORADO RIVER, showing site of sixth attempt to control the Canal. October 17, 1905.



VIEW OF SIXTH ATTEMPT, looking North from Island. November 20, 1905.

Whether or not this attempt, when tested, proves successful, however, the damage being continually done to this region can not be expected to end at once. Several hundred thousands of dollars damage has already been done by the truant river, and even if the surplus flow into the Sink is stopped by the new gates, the lake that covers Salton and its salt works will still remain, which evaporation, almost unaided, will have to drain. It will therefore be a long time before Salton, the submerged headquarters of the New Liverpool Salt Works, can be replaced upon the map and the Southern Pacific Railroad reconstructed upon its old road bed.

The damage that threatens this sunken area, in case the river is not controlled, has already been briefly mentioned. If for some unforeseen and improbable cause the present attempt should fail or be abandoned, and no other attempts inaugurated, the water would gradually cut the present irrigation canal so deep that the entire flow of the river would be side-tracked into Salton Sea. The water would slowly rise until a lake would be created as large in area as, or larger than, Great Salt Lake of Utah, and the entire Imperial Valley, which thus far has not suffered, would be covered with water. The lake would not only rise to the sea-level line, but instead, on account of the elevation of the enclosing rim, it would have to reach to an elevation of fifteen or twenty feet above sea level, at which point it would overflow the south rim near Volcano Lake and pass southward until it would again enter the Colorado River near the Gulf. Should it be the desire at any time to convert this area into a sea-level lake, this outlet channel, which would pass over very loose soil, could be dredged very easily into a sea-level inlet from the Gulf.

To fill this sunken area with water from the Colorado River would require many years. The average flow of the river during a year is said to be about 15,000 cubic feet per second. This entire amount conveyed into the lake would be subject to a very great shrinkage from evaporation, and it is even possible that this loss would become so great after the lake had spread over a certain area as to equal the inflow from the river, although such is hardly probable. In any case, all attempted computations of such nature would necessarily be very inaccurate, and may as well be omitted.

In studying the possibility of this area becoming the bed of an inland sea there are even more considerations to be met than are offered by the Imperial Valley land colony and the salt works at Salton. Gilbert E. Bailey, M. E., of Los Angeles, a recognized authority on the mineral resources of California, has made a thorough study of this region, and to the writer he has furnished a partial list of its possibilities in this direction. In addition to the salt deposits, large quantities of nitrate, sulphate and carbonate of soda are found at various points

along the rim of the desert, and in the southern part there are about 300 acres covered with mud volcanoes or geysers that spout forth mud of various colors and consistency, containing rare minerals which some day may become of importance. Oil-bearing rocks are found along the west side, forming a belt at the foot of the mountains and extending into the area lying below sea level, from which ooze heavy asphaltic oils, and which will some time develop into a rich oil-producing district. South of the California line, in Mexico, and lying below sea level, there are also valuable and extensive deposits of sulphur; and then in the surrounding mountains, which, however, would not suffer from the lake, are found large deposits of gold, silver and copper and mines of kunzite and tourmaline gems.

Altogether, this is an interesting country. It offers many realities, and as many, or more, possibilities. At present it is battling with an unusual problem, and we are assured by engineers that it stands on the eve of victory—at last. It has met defeat bravely six times, and therefore let us hope that the seventh attempt will be crowned with reward.

Author's Note.—About the first of last November, shortly after this article was written, the dams and headgates constructed to shut the Colorado River out of Salton Sink were put into use. Up to this time the Southern Pacific Company, after finishing the headgates mentioned, had continued work until it had practically diked the river for a distance of more than ten miles, and had expended upon the work a sum in excess of $1,500,000. The test of the completed work at that time seemed to assure the successful capture of the runaway river, and there was general rejoicing. A month later, however, the river rose to flood tide, and on the night of December 7, last, it again broke through its natural channel bounds and is again pouring into Salton Sink. The condition to-day is as bad as it was six months ago, and the possibilities of a permanent 'Salton Sea' are now more pronounced than ever. The river must be controlled within six months, or the Imperial Valley will suffer greatly. The Southern Pacific Company, at present, hesitate to again fight the river, and it is probable that the United States government will be asked to lend assistance. The recent break occurred just below the new dike, and has already eroded a canyon-like channel. As pointed out by the writer, the banks of the Colorado River in this vicinity are low and of a very loose material, consequently easily eroded, and to assure a lasting solution to the problem about twenty more miles of dike will be necessary. This, too, must be built soon—before the river channel above the break is cut much deeper.

THE SANITATION OF AIR

By KONRAD MEIER
NEW YORK CITY

HYGIENE, as a science, traces the causes of disease to which mankind is exposed in every phase of life. Its practical value lies in the preventing of these causes, through the sanitation of our surroundings and the rational care of body and mind. The gradual improvement of public health and the incident saving of vital energies as the result of true hygienic living would easily make this field of knowledge rank among the most potent factors in the development of races. Unfortunately, its greater possibilities are not yet being realized, for want of application, which is, as yet, too much confined to the professions directly concerned with matters of health. The principles of hygiene must be brought home to the people at large, must grow into and form the habits of our daily life. They should, in fact, be applied in every craft and trade, led by the professions, as, for instance, by architects and engineers, upon whom depends largely the healthfulness of our homes, of a multitude of public utilities, and of the commonwealth as a whole. In architecture and engineering, the problems bearing on health should be approached in a spirit independent of mercenary considerations. They ought to be solved strictly on their merits, with a fair perspective towards hygienic quality in all questions of serviceability, ornamental features and structural needs. Such quality is often necessary to the full realization of the aim, and essential to true artistic value as well as to material success. We can not ignore the laws and lessons of nature in building up the city of enduring beauty.

In crowded industrial and commercial centers, the excessive vitiation of the atmosphere has grown to be an important factor bearing on public health. While a systematic supply of pure air to buildings has long been recognized as a necessity, the state of the outer air has not yet received the attention it deserves, and is too often accepted as a matter beyond control. Nevertheless, an inquiry into the sources of its pollution will readily show that much of it might be prevented. That it ought to be prevented is becoming more apparent as its bearing on prevailing diseases is definitely being established. The movement for better ventilation would also gain through a closer study of the causes of impure air. Abundant literature exists on standards of purity, on temperature and humidity, also on the amount of air to be

supplied per capita, but comparatively little effort has been made to trace out and bring to light the less evident and often unsuspected factors of contamination, which indicate, or at least should help to determine, the logical method of relief.

The sanitation of the air is a field which has hardly been recognized as such, at least it is not carried on systematically, with that end in view, and the results of present efforts, on the whole, are distinctly behind the progress made in other lines. Indeed, its failure to meet the aggravated needs of our crowded and growing cities can actually be traced on their vital statistics.

The Bearing of Impure Air on Health

An exceptionally clear exposition of the process of breathing is contained in the short essay, 'Air, and its Relation to Vital Energy,' by Professor S. H. Woodbridge, of the Massachusetts Institute of Technology. The oxidation of organic matter within the human body is likened to the process of combustion in a boiler furnace. This analogy applies to every essential point and shows that the conditions making for efficiency in artificial heat production are also those which bear on vital energy. The intensity of combustion within the human body depends upon the rate of exchange between the carbonic acid contained in the venous blood and the oxygen brought into the lungs, or the rapidity at which the waste products brought in from the system are being diluted. A slight abnormal accumulation of this gas in the air cells of the lungs would check this outward leakage or expulsion of waste products and retard regeneration of the blood, but respiration automatically regulates this function. Exhausted air, with deficiency in oxygen and excess of carbonic acid, to sustain equal force, thus requires increased respiration, an unconscious effort, gradually lapsing as the gathering waste products react upon the blood and through it upon vitality. The weakened light of a candle flame in exhausted room air very aptly illustrates also its effect on human beings.

Exhausted Air.—Recent experiments by Fluegge, the eminent German investigator, seemingly contradict this theory. At least they make it appear that the paucity of oxygen and the simultaneous increase of carbonic acid and other waste products, have no appreciable ill effect on the average adult, but that the depression of spirits, headache and drowsiness felt in crowded, ill-ventilated assembly rooms are principally due to disturbance of the thermal functions of the body through heat and moisture. Since these excesses in temperature and humidity always accompany exhaustion they should certainly be regarded as contributory factors, which help to depress the vital powers according to their prominence. It has been asserted, also, that the human organism has long been used to the frequent breathing of foul air, and will

adapt itself to any condition tolerable at all in the long run. This is true to an extent, as to the products of breathing as well as to temperature, but it is more than likely that any immunity from the habit of living in badly used air is gained at the expense of vitality.

Contaminated Air.—As distinguished from 'exhaustion' of air, or shortage of oxygen, with the corresponding increase of carbonic acid and other waste products, the term 'contamination' may be applied to impurities of gaseous and solid nature, aside from the normally unavoidable. This includes, for instance, gases and vapor from industrial sources, also smoke, soot and dust with its attendant bacteria.

The amount of carbonic acid found in air is commonly regarded as a measure of the degree of vitiation, but wherever pollution of the air is likely to occur independent of an increase of combustion or respiration that method of testing the purity naturally is deceptive. Indeed, contamination quite often predominates exhaustion, and should always be considered by itself, as a separate factor, according to the nature of the case. While the effect of exhausted air may have been overestimated, the bearing of contamination on health does not seem to be sufficiently realized. Its claims on vitality are of a different nature. Any admixture of foreign gases may react directly upon the blood. Such poisoning, however, is mostly due to local sources, readily detected and prevented. By far the greater mischief is done by the solid impurities afloat in the air. Although these are normally arrested by the moist, mucous surfaces of nose and throat, they will, under certain conditions, enter the lungs, fill the minute air chambers and lodge there indefinitely. Through life in smoky or dusty surroundings large portions of the lungs become useless in this manner, invite decay and the fatal attacks of bacteria. Dr. Louis Ascher, in publishing the results of his exhaustive investigations on the subject, has shown conclusively that smoky atmosphere encourages diseases of the respiratory organs, materially shortens the life of consumptives and bears distinctly on the mortality of afflicted districts. The charts of distribution of pulmonary tuberculosis in Chicago show indeed the cases to be most frequent near the cluster of railway stations. The appalling contingent of lung patients sent to the Rocky Mountains from our smoky cities of the middle west gives a sad testimony to these facts.

Still greater mischief is done by solid impurities, especially dust, as the carriers of disease germs. True, the best authorities now agree that the presence of microbes in the respiratory organs does not necessarily produce disease, and that the germs must first make their way into the system in order to develop, and find it in poor condition before they can do serious harm. Predisposition, in the form of inflammation combined with lowered vitality, seems therefore necessary to develop the more serious pulmonary diseases. Unfortunately these predisposing

ailments are very prevalent and almost unavoidable, to judge only by the numerous traces of mucous sputum displayed on public thoroughfares, mostly witnesses of chronic catarrh. The first irritation is not always caused by exposure to cold, dryness or humidity, but often by soot and dust, or the depressing conditions of indoor and city life generally. As to the effect of these impurities on diseased tissue, we have recently come to authoritative information through the report of the committee on the influence of climate, made before the National Association for the Study and Prevention of Tuberculosis. By analysis of the various factors contributing to a successful cure, it was found that good results may be secured under most widely differing climatic conditions, the benefits of relative humidity, temperature, altitude, etc., being practically dependent upon the patient's general condition or constitution. It has been found, however, that, when other things are equal and the same attention is paid to diet and hygiene, the best results have always been noted where the atmosphere was purest. Indeed the report places 'Abundance and bacteriological and chemical purity of the air' as first among the beneficial influences, while the value of sunshine and the therapeutic effects of coolness, dryness, etc., are placed next in order of importance.

Surprising results seem to have been obtained lately by the outdoor treatment of pneumonia, in which very probably the greater purity of the air is a contributing factor. The success of the fresh-air colony at Seabreeze also confirms the theory that the cure is greatly assisted by the pure sea air, that is, by the absence of dust and bacteria, which irritate, and continually bring renewed infection to the receptive diseased parts. It is for this reason that outdoor life, almost anywhere, is beneficial to lung patients, since they avoid at least some of the multifarious, insidious forms of contamination peculiar to the air in the average dwelling.

All these facts point to the meaning of impure atmosphere in densely populated cities, where the seeds of disease are most abundant, and the field for infection is prepared for it, fertilized, so to speak, by all sorts of conditions and modes of life, more or less beyond one's control. A good crop of pneumonia and kindred diseases seems assured for the winter season, when the tax on vitality is severest, and indoor life in unsanitary quarters supplies the opportunity. This seems almost sufficient to explain the present situation in our large cities, which has brought about the organization of the Pneumonia Commission through the New York Board of Health. In this connection, Dr. Herman M. Biggs, the general medical officer of the board, has stated, that the number of victims claimed yearly by pneumonia increases steadily and alarmingly. In New York City alone during the first six months of 1905 one third the total number of

deaths were charged to acute respiratory diseases and pulmonary tuberculosis. During that period the deaths from these causes numbered 14,091. In the corresponding period of the year before they aggregated 10,890.

When we compare the efforts of the sanitary corps in this particular direction with the systematic and thorough work done in checking certain epidemics, we can not fail to note the lack of a comprehensive system in fighting diphtheria, grip, pneumonia and other respiratory diseases, which now claim a majority of victims. The situation seems to be recognized, but is met only to a limited extent. Much good has been accomplished through sanitary inspection, stricter enforcement of the regulations against expectorating in public places, also by exhibits and other educational work, but there are many other possible lines of action which should be taken up as parts of an organized campaign for the sanitation of the air. Since the most promising measures must always be of the preventive order, we should, above all, study the causes which lead to unwholesome atmosphere.

The Causes of Impure Air

Quantities of smoke, vapor, dust and other offensive waste products are constantly discharged into the atmosphere of urban districts. The emanation of all this matter is so rapid that it becomes visible within a few hours whenever the purifying breezes die away, and yet the gathering gloom is not generally recognized as pollution of the air, but rather taken for a change in weather. According to the seasons, the solid particles like soot and dust will cause a haze, or encourage the formation of mist and fog, sometimes, during the winter, depriving a city for days of the life-giving sun.

The sources that contribute to this pollution of urban atmosphere naturally increase with the population, while the dispersal of impure matter by the natural air currents becomes more sluggish and uncertain with the growing areas of urban settlements. The density of population in certain metropolitan districts is easily ten times that of smaller cities. The rate of vitiation of the air through smoke and other waste matter must therefore be at least that much greater. Comparatively speaking, the conditions of health in a crowded community are like those prevailing on board ship. The living space is still smaller than that of the average city dwelling, but the elements contributing to the vitiation are about the same per capita, hence more concentrated and more in evidence. We know that extra labor and care are necessary on a vessel to maintain the air in a tolerable state, quite irrespective of ventilation. In cities, where dwellings and shops are built not only closer together, but are literally piled up on each other, the general contamination is likewise bound to become unwholesome unless special

care is taken in disposing of waste matter that may find its way into the air. No doubt more is being done in this direction than in former days, but the rapid concentration of living quarters and industrial shops brings with it new conditions. It should be remembered that it is our pressing duty, and part of that civilization which has built cities for millions, to keep them not only inhabitable, but healthful, wholesome and pure. Elbert Hubbard in the course of his travels once observed that 'The path of civilization is strewed with tin cans.' This certainly insinuates that we have not yet arrived, while tin cans and a multitude of other witnesses of neglect in civic duty are seen along the path.

The Smoke Nuisance.—Smokeless combustion is not only feasible for almost any kind of coal, but more economical if properly attended. The principal difficulty exists in the design of the proper furnace to suit the fuel and to meet the conditions under which it is burned. There ought to be no restriction on the use of bituminous or any other coal. On the other hand, no excuse should be accepted for black smoke from any source within city limits. If not willing or able to suppress it, the offensive industry must be made to move. But all the smaller and innumerable sources of medium, light and invisible smoke should also receive attention. They emit, in reality, by far the largest share of it in the average commercial and residential community, less noticeable because more diluted, but none the less objectionable. The reduction of this smoke is, for practical reasons, beyond control of local health authorities, but it can gradually be eliminated through individual action; that is, by the general concentration of light, heat and power service. The movement in this direction was started long ago with the introduction of central stations for light and power, but it is capable of much greater extension, particularly for heating and power. The bulk of the fuel should be burned at the mine, or at tide-water outside of city limits. Such concentration of combustion for various needs represents a material saving in the total amount of fuel consumed, and, therefore, of the smoke produced. It would incidentally avoid the handling of much coal and ashes and reduce the large amount of exhaust steam now seen pouring away from the numerous individual plants in certain neighborhoods. On still days, these vapors contribute perceptibly to the murkiness of the atmosphere. *The use of steam power for transportation in urban and densely populated suburban districts has long since ceased to be a necessary evil and should have been prohibited years ago.* It is gratifying to state that at last this much-needed economic and sanitary reform seems about to be realized.

Street Dust.—Dust of the streets is one of the principal elements in polluting the atmosphere. It is made up of innumerable substances utterly defying description. To what extent it permeates the air, even

in buildings, is proved by a microscopic examination of deposits from furniture, which shows a large percentage of animal refuse, mostly horse offal, ground up by the street traffic. 'Dirt is useful matter in a wrong place,' was one of the lamented Colonel Waring's maxims. He had, indeed, not only succeeded in removing it, but was in a fair way to make it pay for the cost of removal. Sanitation and economy often go hand in hand.

Concerted action is necessary to suppress this nuisance. No one should complain about dust who is not doing his share in preventing it. Each citizen must be his own sanitary officer and each sanitary officer and employee must be made to attend to his duties on public property. Corporations operating public conveyances should also be strictly held up to their duties. A case which illustrates this point is the New York Subway. Dust from the streets, mixed with sputum and sweepings from within, are permitted to accumulate indefinitely on a road-bed of gravel, which can never be thoroughly cleaned. The trains continually stir up some of this accumulation and impart it to the air. *This is an inexcusable offense from a hygienic point of view.* We need only consider that an underground route has not, like a surface railway, the natural assistance of wind, rain and sun in maintaining salubrity, and that it requires extra care and attention to make up for such disadvantage. The drippings of oil will not altogether bind or lay the dust, and the present method of drawing in air through dirty sidewalk gratings can not improve matters in this respect. An easily cleaned surface and effective mechanical means should be provided to keep the road-bed and the entire tunnel 'clean as a hound's tooth.' The stuffy atmosphere often noticed in the subway is largely traceable to these impurities, which are more objectionable than the heat and the exhaustion of the air. The latter, after all, may be regarded as temporary drawbacks, while dust and bacteria inhaled during the shortest transit will cause infection, threatening disease to any one predisposed. Unless built and operated with a reasonable appreciation of hygienic science, subways may at times become a serious menace to public health, especially when grip and similar epidemics are prevailing.

Causes for Impure Air in Buildings.—Among the numerous factors which may contribute to vitiate the air in buildings, some can always be eliminated, while others are unavoidable and should be counteracted by ventilation, in one form or another. Acting on the principle that prevention is better than cure, we should pay attention first to the avoidable sources. Waste matter of any kind is certain to contaminate the air without necessarily being perceptible by odor or by any of the customary methods of testing. Dust and dried-up sputum from the street, brought in by the air or by clothing, unless frequently removed, will permeate carpets and draperies, from where it is continually

stirred up, thus filling the air with all sorts of impurities, irritating and disease-bearing. The stuffy atmosphere one notices when entering certain assembly halls and churches is nearly always due to lack of energy or method in cleaning, quite often through inaccessibility in 'dirt corners' or other hygienic fault in the design of buildings.

The combustion of gas and kerosene in living rooms rapidly vitiates the air. Each burner will use up as much oxygen as several persons, besides generating heat, moisture and often sulphurous acid gas, specially injurious to nose and throat. *Stoves or grates for heating or cooking by gas should invariably be connected to a flue to carry off the products of combustion.* Even if used for lighting only, the discharge from lamps becomes very objectionable without ample provision for its escape from the room.

Smoke and vapors are unavoidable wherever cooking is going on, but through immediate and effective removal at the starting point, their spread can be prevented. There is no excuse for any odors invading the living rooms; indeed, if the vapors are properly taken care of, the air in the kitchen itself can be kept reasonably wholesome and pure.

Dust, smoke, gases or hot air from industrial sources which are often allowed to contaminate the air in workshops and laboratories can be classed as avoidable factors, since it is nearly always possible to localize them. Grinding wheels, buffers or other machinery should be equipped for this purpose with devices for mechanical suction to pick up and remove the dust or fumes before they can spread and do harm. Poisonous gases in laboratories should also be removed as soon as generated. Waste heat which would otherwise become annoying should be neutralized by insulation. The design of such arrangements requires special training and experience, but the principles of it can easily be understood and insisted upon by laymen.

The Vitiation of the Air through Heating, Cooling and Ventilating Apparatus.—Every one is familiar with the discomforts of modern heating apparatus. The most frequent complaints are of dryness, disagreeable odors or stuffy atmosphere, sometimes combined with overheating. These conditions are so common that they have almost come to be regarded as unavoidable drawbacks, more or less peculiar to certain methods of heating.

Since the capacity of air to absorb moisture increases with its temperature, heating, by any method, will have a drying effect. In clear cold weather, when the atmosphere out of doors contains little moisture, the relative percentage indoors may drop below a point to which most persons are acclimated. Unless made up by internal sources, some artificial supply of moisture seems desirable in such cases. It is, however, not necessary and not desirable, as is often recommended, to go

beyond, or even as far as, making up the deficiency caused by heating, since the human system is used to considerable changes without any real discomfort. Indeed, dry air, *if pure,* is probably more beneficial to normal adults than moist air. The principal reason why the demand for moisture in heated rooms has arisen is the irritating effect of floating dust which has been set in motion by the heating system, directly or indirectly. In the worst form this may be noticed with hot-air heating through floor registers, which invite all sorts of rubbish to fall into the flue, only to be dried and sent up again, often directly into one's nose. Radiators also, especially those with inaccessible surfaces, will gather dust. When cold, it will lay there and molest no more than that on furniture, but as soon as heat is turned on, the tiny drops of moisture, which always cling to these solid particles, will evaporate. Free of this weight, the dust is easily set in motion by the currents of warm air rising from the radiator, as may often be seen by the tell-tale shadows on the wall above. *Heating apparatus thus contaminates the air with dust and bacteria which otherwise would lay undisturbed and out of harm's way.* Moistening of the air will not prevent this to any extent. It increases, in fact, another source of contamination, still too common with modern heating systems—the dry distillation of the organic matter on hot surfaces. This phenomenon has recently been studied by the noted hygienists Professors Esmarch and Nussbaum, who have independently reached the conclusion, that organic dust begins to distil or singe when a radiator reaches a temperature of about 165° F., and that this process is rather encouraged by moisture, probably because the hygroscopic matter clings longer to the heated surfaces and is therefore decomposed before it rises up in the air. *To reduce the vitiating effect of heating apparatus, we must insist on the most accessible and simple styles of radiators,* on which any dust can readily be seen and is apt to be removed, and on ample heating surfaces of moderate temperature which will tend to avoid the decomposition of organic matter.

Overheating by itself must be considered as vitiating the air; at least in so far as it makes it unfit, or less wholesome, according to some noted hygienists who have thoroughly investigated its effect. It seems, at any rate, to give the air a lifeless quality, which soon imparts itself to the victim of our wasteful modes of heating.

Apparatus for artificial moistening, which is now often installed in connection with heating and ventilating systems, aside from the liability of exceeding the desirable humidity, also gives opportunity for contamination of the air supply. Unless the devices are designed on sanitary principles and intelligently attended to, they are very liable to become foul and malodorous, if not unhealthy.

Like the heating of buildings, artificial cooling may also have un-

wholesome effects. Special provision must be made for drying the air to keep down the relative humidity in the rooms so cooled. In moist and warm weather it would otherwise reach the saturation point. Such a condition is not only uncomfortable, but can become very unhealthy. The science of artificial cooling is as yet very little understood by the average layman and any devices which do not give perfect control over humidity must be cautioned against.

Ventilating apparatus itself may become a source of contamination if improperly designed, operated or maintained. Air filters have been found, for instance, which were intended to arrest the dust, but actually also arrest nearly all the fresh air. Some of these filters can not be cleaned or renewed without spilling the very impurities collected into the air ducts and thence into the rooms. Mechanical ventilating devices too often defeat their usefulness by lack of control over air currents and temperature, which either puts them out of service, or the persons for whose benefit they were intended.

Vitiation through Animal Life.—The last, but not the least, among the sources of vitiation is the presence of animal life or of man. Theoretically, perhaps, this may be called the only unavoidable factor, or the one which must be met by ventilation. The exhalation of carbonic acid in place of the oxygen inhaled reduces the life-giving quality of the air, or its power of regenerating the blood. Exhaled air, moreover, is charged with vapor and organic matter. The substance, called effluvia, which emanates from the surface of the human body is also of organic nature. It is harmless enough when permitted to dry and disperse, but in the moist and warm air of over-crowded rooms it quickly putrefies and becomes obnoxious. It can be recognized by that pungent odor characteristic of a sweltering mass of people. Whatever ill effects may be due to effluvia come through the action of odor on the nerves, rather than through inhaling this comparatively innocuous matter. The excess of heat and moisture produced by an audience as previously mentioned is now regarded as more than a temporary discomfort, quite aside from the danger in subsequent exposure to cold. Exhaled air, effluvia and heat thus combine, in varying proportions, to make room air unfit for breathing. In crowded meeting places they are the principal sources of vitiation, which may practically determine the artificial supply of air, while, for instance, in dwellings, offices and shops with liberal space allowance and plenty of exposure they are often a negligible quantity compared with the sources of contamination.

Suggestions for Relief

The remedy for the unhealthy conditions described naturally lies in systematic sanitation of the air; indoors as well as out-of-doors. The methods of carrying on such work are indicated by the causes

themselves, and some remedies have already been suggested. In regard to open air they are practically limited to measures of prevention.

Sanitation.—The New York Board of Health now sends schoolchildren to dispensaries and specialists for deafness and defective eyesight, in the hope of reclaiming them from the dullness consequent to these ills. This unquestionably helps to keep certain contagious diseases under control, and it may be justified on other grounds, but it should not be forgotten that certain unsanitary conditions, to which such diseases can often be traced, barely receive any attention in the sense of an organized campaign for purifying the air. Particular attention should be paid to the suppression of all markets and other nuisances affecting the salubrity of streets and squares surrounding schools and hospitals. The maintenance of public buildings on strict sanitary lines by systematic processes of cleaning, disinfection, repainting and repairing is also too much neglected. The movement for the better housing of the poor, however much has been accomplished, can only be called a beginning. Hundreds of the better sort of tenements are being built, but thousands are needed. If the health board has the right to condemn old rookeries, to order repairs, to pass on workshops in dingy basements and the like, there is much to be done yet on these lines.

The campaign against expectorating, in which Dr. Darlington, the present New York health commissioner, has taken an active part, is most commendable. It certainly reduces the constant danger of infection, but it does not lead far enough toward stopping its causes, the chronic catarrh and other ills largely induced by untidy streets and buildings, public and private.

Sanitary inspection has long been organized in many cities, for certain classes of buildings, but it must include all public conveyances, conveniences, highways and byways in order to be really effective. It should be supplemented by jurisdiction over hygiene in lighting, plumbing, heating and ventilation of new buildings, and in the maintenance of streets, sewers and other public works. This may seem to be a large ground to cover for the average staff of health officers, but it is not altogether a question of men, but one of influence or power of the board over other departments, which should be made to carry out their own work with due regard for hygienic requirements. Sanitation on these lines would be of particular value as an education to the citizens by way of example.

Hints on Ventilation.—The foregoing arguments should have made it clear that ventilation is not the only cure for vitiated air. It should be regarded rather as a supplementary measure, to be used where other means of sanitation can not or will not give sufficient relief. To ventilate buildings with the impure air from city streets, railway cars with

smoke from the engines, subway cars with dust-laden air from the tunnel, is naturally inefficient and of questionable benefit. Efficiency in ventilation must come through wider streets and courts, cleaner thoroughfares, the abolition of smoke and dust nuisances, and last, but not least, through the design of buildings, engineering work, public conveyances and their equipment on sanitary lines.

Laws have been in effect in several states which prescribe a fixed amount of fresh air to be supplied per capita in schools and theaters. These laws do not cover the standard of purity, except perhaps as expressed by the carbonic acid test, which does not measure the worst forms of contamination. They do not always define temperature and other qualities essential to secure its benefit to people. Moreover, it is almost hopeless to enforce them in the proper spirit. Discretion might often be in order where natural conditions will help, but can not be conceded while the exact volume of artificial supply is prescribed. The chief benefit of such legislation lies in its educational effect on people. *The urgent need to-day is to bring before the public again and again the most objectionable causes of impure air, especially those of preventable nature,* and to promote sound judgment as to the logical and practical means of relief.

Ventilation can be effected by natural, artificial or mechanical means. Each of these three methods has its field for application. Natural ventilation is incidental to the design and construction of a building. Frame houses are subject to considerable leakage through the shrinking wood-work of walls, windows and doors and through their greater exposure to the air generally. Such ventilation may also be called spontaneous. It is generally sufficient in exposed wooden dwellings, at times even greater than necessary. Brick and stone buildings are also subject to more or less spontaneous ventilaton, which, however, does not always meet the need. In such cases, the general design of the building should be arranged deliberately to encourage a natural ingress and egress of air. For residences and offices not unduly crowded, this may suffice with a fair exposure, but often it should be supplemented by artificial means. This implies that the building must have certain features which induce a decided movement of air, such as shafts leading from kitchen and inside rooms, also fire-place flues and vents from special sources of odor. With such provisions an active removal of foul air may be effected by differences of temperature, increased possibly by waste heat available. The leading idea should be to give the most advantageous direction to the natural currents of air. Systematic supply of fresh air, combined in some form with the heating apparatus, is appropriate in many cases, particularly as it permits some control over the purity, temperature and humidity of the air entering the building.

Mechanical or forced ventilation finds application where the number of people, excess of heat, or other conditions creating unwholesome atmosphere, can not be overcome by any other method. Theaters and crowded assembly halls, class rooms, hospitals, certain laboratories and workshops, hotel kitchens, public smoking and toilet rooms, generally need a rapid renewal of air. The ventilation of such places should be positive, that is, it should not be dependent to any extent upon weather or temporarily favorable conditions. Of course, when subject to spontaneous ventilation, such rooms will require less of the artificial kind. Indeed, it is important always to utilize the natural means at hand, and to omit none of the preventive measures that may help to relieve the situation. *Buildings should be designed with due regard to airing and to avoid, if possible, the necessity for a mechanical system.* The latter should always be considered as a sort of emergency device and reduced to the utmost simplicity consistent with the need. Of course, simplicity must not be secured at the expense of quality or efficiency. The latter depends mostly upon the purity, perfect distribution and the control over the temperature of the air supply. Moderate volumes, well applied, are better and more economical than large quantities indifferently, indiscriminately, almost criminally introduced. When designed and equipped on the right principles, buildings will be less dependent upon the uncertainties of complex machinery, incompetence or indifference of operators, parsimoniousness of owners, and all those contigencies which so often have turned a well-intentioned, but too complicated, apparatus into a dead letter, a lot of junk, or even a nuisance and a menace to health, instead of a means of relief. The undesirability of mechanical devices increases rapidly with their complexity and age. Deterioration is bound to set in. The simplest means to accomplish the end is not only the most economical, but it is the best guarantee for successful operation in the long run.

Building Reform.—The extreme utilization of space which is the common tendency in much of our urban architecture has passed the sanitary danger line. There are too many investors, or speculators, who do not care whether a structure is fit for habitation. Unfortunately, architects do not always realize the meaning of the demands put upon them, and that those exaggerated proportions, growing out of the fight for light and air, will make sanitation more difficult and are unfair to the neighbor. *When building on a plot of ground, any adjoining property should be given an equal chance for vertical expansion,* giving leave to any one to do unto you the same, with profit. Some of the flagrant encroachments lately seen upon other men's right to nature's freedom have really been nothing short of criminal. The limitation of the sky scraper is really but a question of fair dealing with one's neighbor.

The campaign for tenement-house reform, lately rewarded by splendid results, has been a step in the right direction. Its bearing on the building laws is one of the most important benefits. The provisions calling for greater court area and other features calculated to relieve crowding and to assist natural ventilation should be made even more sweeping *and extended to all classes of buildings.*

To improve the housing, for rich and poor, and to make a city more healthful generally, we must aim to relieve this excessive crowding. A good beginning has been made by the fight for small parks. More of these breathing spots are needed, sorely needed. Healthy playroom for the children of those unbroken rows of flats is hard to obtain, but it must be secured, if only to break up the monotony of brick and stone and relieve it with some wholesome vegetation, cooling, purifying bits of nature. Even if limited to a single block, small parks could be utilized for schools, as is done frequently in smaller towns. This would be really the ideal way of securing their full benefit, the children profiting in the day, adults in the evening, and the neighborhood all the time. The plan of locating public buildings and schools on open squares or parks may be luxury in country towns, *but it is a necessity in large cities from a sanitary point of view.* This idea, once recognized and rooted, might be the wedge for a new method of securing sites, of making the school the excuse, or rather the necessity, for another small park. It should at once be adopted in outlying districts where space is less expensive. The finest sites set apart for public institutions have never been found too good and always will prove the best investment of public funds from every point of view. It can not but influence the private owner to plan and build with a broader purpose than the immediate commercial gain, which has demoralized the arts and crafts, the architecture of the day, and will be a testimony to future generations of the materialism of our age.

To bring daylight into the dwellings of the ignorant masses is to educate them and to banish dirt, filth and disease. More light incidentally brings more air and purer air. But there is need for sanitary reform also in the dwellings of the rich. It should begin with more sensible building plans, a return to simplicity in design and construction with a view to inducing salubrity as the first principle of hygiene. It is not so much the quantity of air that is to be considered, but rather the quality. Let us have not only more air, but purer air, as from the open country or the sea. Sanitation of the air is a lesson taught by nature. Civilization must apply it for humanity, for the wholesome enjoyment of life to all.

THE JEWS: A STUDY OF RACE AND ENVIRONMENT. IV.

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NEW YORK

Mortality

THE bulk of the Jewish population in the orient and eastern Europe lives mostly in the oldest and most congested parts of cities amid squalid and unsanitary surroundings, where the mortality rates are, by general experience, known to be excessive. Physically, the eastern European Jews appear to be weak, anemic and decrepit when compared with the christian population, and in addition they are mainly engaged in indoor occupations. These peculiarities would lead one to expect *a priori* that the mortality rates among them would be much higher than among other people, who live mostly under better hygienic and sanitary conditions, have a large proportion of agriculturists who live in the open country, and are engaged in outdoor occupations, and to all outward appearances are more robust and healthy. It is a remarkable fact, however, that the contrary is true. The figures in the appended table, giving the results of most recent official censuses

Country.	Year.	Annual Mortality per 1000.		Mortality of Christians 100, Jews —
		Jews.	Christians.	
Algeria	1901	20.58	23.14	88.93
Roumania	1902	20.02	29.06	68.54
Cracow (Galicia)	1895–1900	19.70	35.90	64.00
Warsaw (Poland)	1901	18.22	24.59	74.09
European Russia	1897	17.82	36.49	48.81
Hungary	1903	17.29	27.24	63.47
Austria	1901	17.26	25.18	65.93
Hesse	1901–1904	14.80	19.10	77.48
Prussia	1904	14.22	20.44	69.57
Berlin	1904	13.32	17.12	77.80
Prague	1901	13.26	20.02	66.23
Budapest	1903	13.20	19.00	69.47
Amsterdam	1900	12.27	17.44	70.36
Bavaria	1902	12.11	23.08	52.47

in various countries, show that the rates are much lower among the Jews than among other Europeans. Only in Algeria and Roumania do the rates exceed twenty per 1,000 population, but in all the other mentioned countries the annual rates are less than twenty: In Poland (Cracow and Warsaw) it is between 18 and 19; in European Russia, Hungary and Austria, 17; in Prussia, 14; in the capitals of Prussia, Bohemia and Hungary, only 13; and in Amsterdam and Bavaria the low rates are almost unprecedented, only 12 per 1,000. A yet lower

mortality rate was found among 10,618 Jewish families, including 60,630 persons living in the United States December 31, 1889. In the figures published in Census Bulletin No. 19 (Washington, December 30, 1890) it appears that the death rate was only 7.11 per 1,000, which is but 'little more than half the annual death rate among other persons of the same social class and conditions living in this country.'

The low death rates of the Jews are more strikingly demonstrated when compared with the mortality of the christian population of the countries in which they live. This is done in the fourth column of figures in the table; the mortality of the non-Jewish population is taken as 100. It is seen that the Jewish death rate in Algeria is but 89 per cent. of the mortality of the other Europeans in that country; in Bavaria it is a little over, and in European Russia even less than, fifty per cent. of the christian mortality. In other words, the death rates of the Jews are from eleven to fifty per cent. less than those of the christians.

These favorable mortality rates of the Jews are not a recent phenomenon. At all times when statistics on the subject were compiled it was found to be the case. The censuses of Prussia give some very interesting figures in this connection. The rates since 1820 were as follows:

AVERAGE ANNUAL MORTALITY PER 1,000

Year	Jews	Christians
1820–66	20.40	
1878–82	17.53	25.23
1888–92	15.71	23.26
1893–97	14.73	21.84
1900	14.96	21.70
1904	14.22	20.44

It is thus seen that the mortality in Prussia has been sinking in recent years among both Jews and christians, decreasing by about twenty per cent. since 1878 in both groups. This is of course to be attributed to advancement in economic, social, hygienic and sanitary conditions. But it is remarkable that there is no change in the ratio of Jewish to the christian mortality; it was in 1878 sixty-nine per cent. of the mortality of the christian and remained the same in 1904. Hungary is another country where reliable statistics are available for fifteen years. The figures are as follows:

DEATHS PER 1,000

Year	Jews	Christians
1891–95	19.07	33.12
1896–1900	16.87	27.62
1901	16.95	25.94
1902	17.42	27.89
1903	17.29	27.24

Here it is to be noted that the mortality of the Jews was in 1891 more favorable than in 1903. The decrease during the last fifteen

years was more marked among the christians: In 1891 the Jewish mortality was 57.58 per cent. of the christian mortality, while in 1903 it was 63.47 per cent., which indicates that they are approaching the mortality rates of their non-Jewish neighbors. Data for Warsaw, Poland, show the same process: In 1882 the mortality was, Jews 24.48, general population 32.34; in 1891, Jews 20.27, general population 23.05; 1896, Jews 20.42, general population 23.54; in 1901, Jews 18.22, general population 21.22. All this indicates that in recent years the differences in the mortality between Jews and christians are being obliterated.

Death is a biological phenomenon, and can not be influenced by purely ethical or metaphysical factors, such as, for instance, religion, when Jews are compared with christians. Differences in religion are consequently not sufficient to explain the differences in the mortality rates between Jews and non-Jews. Nor can racial affinities explain completely the low mortality of the Jews, because physically the Jews bear a striking resemblance to the non-Jewish races and peoples among whom they live, and also because the differences in the rates are too large in each country to admit racial uniformity. A study of differences in social and economic conditions is more fruitful of results. Thus, in Budapest the death rate of the Jews was only 69.47 per cent. of that of the christians. But, as is aptly pointed out by Körösi, according to the census of 1891, out of every 1,000 inhabitants there were common laborers, among the catholics 118, among the Lutherans 125, among the Jews only 67; domestic servants were found, among 1,000 catholics 95, Lutherans 98, and among the Jews only 17; merchants were found, among 1,000 catholics 20, Lutherans 36, while among the Jews the figure was 131. These social differences are of sufficient importance to greatly influence the death rates and to account for the favorable showing made by the Jews. As is well known, certain occupations are more deadly than others. When to this are added other social factors which differentiate the Jews from the christians, such as the rarity of alcoholism and illegitimacy among the former, and the proverbial care bestowed by them on their offspring, thus contributing to a low infant mortality, the effects of the social factors become apparent.

Infant Mortality

All this is depicted in a striking manner when infantile mortality among Jews is considered. It appears, namely, from all available data that the Jews do not have the advantage over others when deaths of adults, particularly persons over fifty, are compared. It is only during infancy and childhood that fewer deaths occur among them. In Prussia, where the mortality rates are classified in the census reports

according to the age of the individual whether he is less than or over fifteen years old, we find that the mortality of the young is less than one half that of the christians. In 1904 48.89 per cent. of all the deaths among christians in that country occurred in individuals less than fifteen years of age, while among the Jews only 19.78 per cent. of all deaths were in persons of these ages. In Berlin it was in 1904, christians 42.05 and Jews 20.28, also less than one half among the Jews. In Amsterdam the deaths recorded in 1900 were distributed by ages as follows:

Age	Christians	Jews
—1	25.23 per cent.	18.76 per cent.
1–13	15.68 per cent.	11.72 per cent.
13–64	33.58 per cent.	33.38 per cent.
64+	25.51 per cent.	36.14 per cent.

Here also the mortality during infancy and childhood was smaller among the Jews than among the christians; between the ages of 13 to 64 it was equal among both classes, while among the old it was more frequent among the Jews. The same condition has been found in Hungary, where the mortality of children below seven years of age is 49.5 per cent. among the christian population, and only 43.69 per cent. among the Jews.

Objections may be raised against this method of calculating the mortality of children, because it must first be ascertained whether the distribution of the population by age classes is the same in both groups. This is particularly the case with the Jews, whose birth rates are lower than those of christians. A smaller number of births means a smaller number of infants, and consequently a smaller number of deaths. The best way to compare the mortality of Jews and christians is to calculate the proportion of deaths per 1,000 persons at each age period, *i. e.*, to ascertain the death rates at each age in both classes, Jews and christians. But this is difficult because there are no available data published in census reports. The exact infantile mortality is, however, easily ascertained by finding the ratio of deaths of infants below one year old to the number of births in a given year (excluding still-births). In the following table are given some figures about the infant mortality in some European countries:

DEATHS OF INFANTS PER 1,000 BIRTHS

Country	Jews	Christians
Amsterdam (1900)	92.77	139.56
European Russia (1897)	150.80	274.30
Cracow (1894–97)	155.47	170.84
Hungary (1902)	95.20	164.60

Here also a lower infant mortality is seen among the Jews. Of 1,000 Jewish children born among the Jews in Amsterdam during 1900,

907 survived the first year, while among the christians in that city only 861 survived; in Russia the figures stand, Jews 849, christians 726; and in Cracow, Jews 845 and christians 829. This has a great bearing on the expectation of life of the Jews. According to the calculations presented in Census Bulletin No. 19, 1890, the expectation of life of the Jews is much more favorable than that of the christian population of the United States. Assuming 100,000 Jewish individuals to have been born on the same day (among which there would probably be 50,684 males and 49,316 females), 45,680 males and 44,995 females will survive the first year; 41,731 males and 42,326 females will survive the fifth year, etc. At the end of about 71 years one half of them will be dead. Taking the data for Massachusetts for 1878–82, of 100,000 American infants born (among which there would probably be 51,253 males and 48,747 females) only 41,986 males and 41,310 females would survive the first year; 36,727 males and 36,361 females would survive the fifth year; and half of them would be dead at the end of about 47 years.

While these figures are open to criticism because, as has been pointed out by Hoffman, the method adopted for the calculation of the life-tables is not stated in detail, still it may be stated without any hesitation that the longevity of the Jews in the United States and Europe is superior to that of the non-Jewish population. There is also no doubt that this superiority is mainly due to the lower mortality during infancy and childhood. It is doubtful whether there are any differences in mortality rates during adolescence and middle life between Jews and christians. Among persons of advanced age, over fifty, the rates are higher among the Jews, simply because a larger number reach that age.

The lower mortality of Jewish infants is not due to any special inherent vitality, but finds its explanation in certain social causes: Jewesses in eastern Europe almost invariably nurse their infants at the breast, and it is rare to find among them an infant brought up on artificial feeding. The mortality of breast-fed children is much below that of hand-fed. Jewish mothers only rarely go to work after marriage, and can therefore bestow all possible care on their infants, which can not be said to be invariably true among the poorer classes of population in eastern Europe and America. In western Europe the Jews are economically on a higher plane than the general population, and when infant mortality is discussed it must be recalled that it is much smaller among the well-to-do than among the poor. The Jews should be compared with the wealthier classes of western Europe and not with the general population. To these social factors there must also be added the fact that the birth rates of the Jews are lower than those among the christians. A high mortality can not be expected when fewer children are born. In fact, in Russia, where the birth rate of

the Jews is high (compared with conditions among western European Jews), the infant mortality is also higher, though not so high as the mortality of the Greek orthodox, whose birth rates are the highest in Europe.

Arthur Ruppin, who has studied the problem thoroughly, insists that the superiority of the expectation of life of the Jews is mainly due to the higher infant mortality among christians, which drags down the average duration of life. "To use a coarse example: The expectation of life of a christian child on the day of its birth is, roughly stated, about forty years, as against sixty years of the Jewish child; at the tenth birthday the probable duration of life of the christian child is fifty-five, while that of the Jewish child is sixty-five; and at the twentieth birthday the probable duration of life is, for both, seventy years, *i. e.*, the expectation of life of the christian is equal to that of the Jew as soon as the christian has passed his years of infancy and childhood, and reached adolescence."

"The best illustration," Ruppin goes on to say, "of this condition, is perhaps to be seen when we take definite statistical data of a given city, say Budapest, Hungary. The mortality during 1902 was 14.17 per 1,000 among the Jews, and 21.81 among the christians. The Jews were favored by the following factors:

1. *A Low Infantile Mortality.*—The proportion of death of infants under one year was during that year 9.52 per cent. of all the births from Jewish mothers and 16.46 per cent. of all the births from christian mothers. If the infant mortality was as high among the Jews as among the christians the number of Jews who died during that year would have been larger by 320, and through that the mortality would have been increased by 1.89, *i. e.*, the death rate would have been 16.06 instead of 14.17.

2. *The Lower Birth Rate of the Jews.*—The birth rate per 1,000 population was, namely, 27.29 among the Jews and 32.74 among the christians. If the Jews had relatively as many births as the christians had, the mortality rate, on the basis of the Jewish infant mortality just determined above, would have been larger by 0.48 per 1,000; their general death rate would have been increased to 16.54 from 16.06.

3. *The Smaller Mortality of Children under Ten Years of Age (excepting Infants under One Year).*—The proportion of deaths of children between one and ten years old was 2.15 per 1,000 among the Jews and 3.73 among the christians. If the Jewish mortality at these ages were as high as that of the christians, 266 more Jews would have died during that year, and the general mortality rates would have increased by 1.57 per 1,000, or instead of 16.54 it would have been 18.11.

In this manner one half of the difference in death rates between Jews and christians in Budapest is wiped out. It stands now as 18.11 for Jews, and 21.81 for christians. The remaining difference in the rates of 3.7 per 1,000 in favor of the Jews, can also be accounted for by other social factors, and no special physiological tenacity of life of the Jews need be considered as the cause. One has only to recall that alcoholism is very rare among the Jews, and that the Sabbath

is a day of rest among the orthodox Jews in eastern Europe, and not of drink and dissipation, to find a reason for greater immunity to certain diseases, and to a lesser liability to accidental death. Their occupations also are mainly of the kind in which violent or accidental deaths are not of frequent occurrence. There are, relatively, very few Jews engaged in shipping, mining and dangerous trades generally. The deleterious effects of the indoor occupations in which the Jews are largely employed are mostly manifesting themselves in the anemia and poor physique which are characteristic of them. But, on the other hand, they are rarely exposed to the inclemencies of the weather, and thus acute articular rheumatism, pneumonia, etc., are less often a cause of death among them than among others. In fact, diseases of the respiratory organs, including tuberculosis, have been observed to be less commonly a cause of death among the Jews in Russia, Hungary, Austria, England and America.[1] Their partial immunity to consumption is astonishing, considering that they are mostly engaged at indoor occupations, working long hours in unhealthy sweatshops, and living in the most congested parts of the cities. Perhaps a good explanation may be found in the confined Ghetto life in which they have been compelled to live for centuries, and which has adapted their organism to indoor life much better than other civilized peoples, who have a large proportion of agriculturists and outdoor workers. During the long years of Ghetto life most of those whose organism could not adapt itself to the confined atmosphere succumbed and were thus eliminated. It is a general observation that races that are not adapted to indoor life quickly succumb to consumption as soon as they attempt to live in modern dwellings. Among the uncultured 'blanket' Indians of our western plains, and among the Indians of Peru, the Khirgiz Tartars and other savage tribes of Africa and Australia, all of which live outdoors, the disease is almost unknown. But as soon as the same people are taken to modern cities, they can not stand it, but soon contract various diseases common in large cities, particularly tuberculosis. They have not had the opportunity to slowly adapt themselves to an indoor existence, as was the case with the Jews.

Suicide

That purely social factors are the underlying cause of the low mortality rates of the Jews, and that with changes in their social conditions there occur also changes in the death rates, are well illustrated by the frequency of suicide among them. Statistics collected by Morselli ('Suicide,' p. 122) show that during the third quarter of the last century Jews only rarely committed suicide. He attributes it partly to racial, and partly to religious influences, and maintains that individuals fervently devoted to religion, especially women (nuns and

[1] See 'The Relative Infrequency of Tuberculosis among Jews,' by the author, in *American Medicine*, November 2, 1901.

lay sisters) furnish very few suicides. A study of more recent statistics about the Jews confirms this view. In eastern Europe and the orient, where they are ardently devoted to their religion, a Jewish suicide is very rare; in some cities in Russia or Galicia, with over 20,000 Jews, more than ten years often pass without a Jew taking his own life. During the first half of the last century, when the social and economic condition of the Jews in western Europe was not much superior to that of their eastern European coreligionists of to-day, self-destruction was also rare among them. With the decline of the intensity of religious belief which is characteristic of the contemporaneous Jews in western Europe and America an adoption of the habits and customs of the christian population has been noted, among which suicide may be mentioned as a social fact important for study.

In eastern Europe suicide is even to-day less frequent among the Jewish than among the christian population. In Cracow, for instance, one per cent. of all the deaths during 1895–1900 was self-inflicted among the christians, as against only 0.4 per cent. among the Jews; in Budapest, Hungary, the rates in 1902 were as follows:

NUMBER OF SUICIDES PER 1,000 POPULATION

	Christians	Jews
Men	6.79	4.61
Women	2.35	1.00
Total	4.44	2.88

Suicide is here less frequent among the Jews than among others. But proceeding to western Europe, where the Jews are affected by what Morselli characterizes as the 'universal and complex influence to which we give the name civilization,' the proportion of suicides is at present much larger among the Jews than among christians, although but fifty years ago it was uncommon. Thus in Würtemberg during 1846–60 the rate was on the average annually among protestants 113.5, among catholics 77.9, and among Jews only 65.6 per 1,000,000 population. During 1898–1902 the rates increased to 252 among the Jews and to only 162.7 among the christians. In Bavaria the suicide rates were during 1844–56, Jews 105.9, protestants 135.4 and catholics 49.1 per 1,000,000. Since 1870 a steady increase was noted as follows:

NUMBER OF SUICIDES PER 1,000,000 POPULATION

	Catholics	Protestants	Jews
1870–79	73.5	194.6	115.3
1880–89	95.3	221.7	185.8
1890–99	92.7	210.2	212.4

The increase in the rates of self-destruction among the Jews has thus been so pronounced within the thirty years since 1870 that it is now much higher than among the christian population of Bavaria. The greatest increase has, however, been observed in Prussia. During

1849–55 it was rare among them, only 46.4 per million Jews, as against 49.6 among catholics, and 159.9 among protestants. It so increased in frequency that during 1869–72 it was, Jews 96, catholics 69 and protestants 187; and the increase during the following years was so severe that the Jews outstripped the christians during 1892–1901.

RATES OF SUICIDE PER 1,000,000 POPULATION

	Men	Women
Jews	370.4	124.1
Christians	321.5	81.1

All these figures show conclusively that the rates of suicide among the Jews are not at all influenced by ethnic factors. The social environment is solely responsible for the infrequency of self-destruction among the Jews in eastern Europe, where they live in strict adherence to their faith and traditions; while in western Europe, where they commingle with their christian neighbors, adopting their habits and customs, the rates of suicide increase. Considering that there is a lesser number of children among the Jews, and that suicide is rare among the young, and that they are mostly town dwellers, engaged in mercantile and financial pursuits, there is good reason for the higher rates among them than among others. Further proof of the influence of environment is adduced by the fact that with a change of environment there is also a perceptible change in the suicide rates. The Jewish immigrants in New York city are much given to self-destruction, although in their native homes suicide is very rare. There are no available statistics as to the exact annual number of Jewish suicides in New York city, but an inquiry by Mr. John Paley, editor of a Yiddish daily, elicited the following information: "About fifteen years ago suicide was uncommon among the immigrant Jews, so much so that I always gave each case reported a prominent place in my paper. To-day conditions have changed. There are so many cases of Jewish suicides that unless it is a prominent person, or there are special news features connected with the case, I do not at all mention it in the columns of my daily." He estimates that there are six Jewish suicides on the average weekly in New York City. If this figure is near the truth, and I am inclined to believe it is, then the suicide rate among the Jews in New York is appalling. The aversion to self-destruction of the eastern European Jew is thus seen not to be racial. As soon as he is brought face to face with a more complex life in New York City, as soon as his devotion to his religion is more or less dwindling, any serious reverse in life is liable to discourage him to the extent of causing him to terminate his existence.

IV. *Natural Increase of Population*

From the preceding studies it was evident that the birth, marriage and death rates were everywhere in Europe lower among the Jews than

among their non-Jewish neighbors. It is of importance now to inquire what are the effects of these low rates on the increase of the Jewish population. Population increases, as is well known, by the excess of the number of births over deaths, and it is important to inquire whether the small birth rates of the Jews are everywhere compensated by the low death rates, or whether even their low mortality is insufficient to leave a substantial surplus because the number of births is so small as to be insufficient to replace those lost annually by deaths.

In general terms it can be stated that there are two ways by which a population may replace its losses by deaths: First, by a high birth rate much in excess of the death rate. This is usually the rule in communities in a low state of culture, among agricultural classes, and also among the poorer and laboring classes in European and American industrial centers. The death rate, especially the infant mortality, is very high, but this is compensated by early marriages, and a substantial prolificacy. On the whole, the average duration of life is, in such communities, comparatively short; the population is being renewed at frequent intervals.

Communities in a higher state of culture, on the other hand, have generally lower birth, marriage and death rates, particularly the infant mortality is more favorable. It requires a longer period of time for such a community to renew its population, because the average duration of life is superior. This is observed generally among the upper ten thousand of modern civilized states, particularly in large cities. From a sociological and economic standpoint this method of perpetuation of the population, if kept within certain limits, has its advantages over the former method. To use Spencer's terminology, it decreases the expenditure on genesis, leaving sufficient for individual evolution. In other words, the smaller the number of children born has as a concomitant a smaller infant mortality, and also gives the parents an opportunity to raise their offspring on a more desirable standard.

A glance at the figures brought together in the preceding studies shows that the Jews, judged by the social and economic environment in which we found them, can be placed in either one of the mentioned classes of fertility. To begin with the natural increase, *i. e.*, the annual excess of births over deaths per 1,000 population, it is found that there are great differences between eastern and western European Jews.

Country.	Excess of Births Over Deaths.		Country.	Excess of Births Over Deaths.	
	Jews.	Christians.		Jews.	Christians.
Algeria (1901)	24.09	9.43	Prague (1901)	2.59	11.29
Cracow (1899)	17.70	1.30	Berlin (1904)	3.70	10.24
European Russia (1897)	17.61	16.87	Prussia (1904)	4.49	16.49
Austria (1901)	16.63	11.83	Bavaria (1900)	4.60	12.60
Hungary (1903)	14.90	10.68	Hesse (1901–1904)	4.70	14.90
Roumania (1902)	12.34	13.80			

In the former the excess is large, while in the latter it is small. This is seen from the table given above.

In Algeria, the only oriental country where vital statistics of the Jews are published, the natural increase is very great. The social conditions of the native Jews in that country are purely oriental. Early marriages are the rule, and celibacy almost unknown. This brings about a high rate of fertility; their birth rate was 44.67 per 1,000, with a correspondingly high mortality rate of 20.58. But after all the excess of births over deaths is large, reaching annually 24.09 per 1,000. In European Russia, where social conditions of the Jews are more occidental, the excess of births is smaller, only 17.61; in Austria, 16.63; in Hungary, 14.90, and in Roumania, 12.34. All these eastern European Jews show rates of natural increase characteristic of eastern people. Proceeding to western Europe we find a different condition of affairs. The rates of proliferation are low, owing to the low marriage and birth rates; even their favorable mortality rates are insufficient to leave a substantial excess of births over deaths. Thus in Bavaria the natural increase was during 1900 only 4.60, while among the non-Jewish population it was nearly three times as large, 12.6; in Prussia the natural increase was in 1904, Jews 4.49, and christians 16.4; in cities it is even lower, only 3.70 in Berlin (10.24 among christians) and in Prague 2.59 (11.29 among christians). The influence of social and economic conditions on the natural increase of the Jews is well displayed in the various provinces of the Austrian Empire. In Galicia, where the majority of the Jews live in poverty and want, and are rigidly devoted to their religion, the natural increase was during 100, 17.92 per 1,000 (christians, 16.61); in Bukowina, where conditions are about the same, it was 12.66 (christians,15.83); but in Lower Austria where their social, intellectual and economic conditions are much superior, it was only 7.69, while in Bohemia, where the majority of the Jews are well-to-do and are socially comparable with the western European Jews, the natural increase is very low, lower even than in Berlin, only 1.35 per 1,000 (christians, 10.76). There are good reasons to believe that in Italy, France, England and the United States, the same conditions prevail among the native Jews.

These conditions are only a recent phenomenon among the Jews in western Europe. During the first half of the nineteenth century the excess of births over deaths was equal, and even superior to that of the christians. In Prussia, for instance, the average annual birth rate during 1822–40 was 35.46; the death rate, 21.44; leaving an excess of births over deaths of 14.02 per 1,000, as against only 10.40 among the christian population (births 40.01 and deaths 29.61). This excess began to sink gradually but regularly, as can be seen from the following figures:

EXCESS OF BIRTHS OVER DEATHS

	Jews	Christians
1885	10.33	12.29
1890	7.64	12.58
1895	6.66	15.12
1900	4.52	14.57
1904	4.49	16.49

Similar conditions are observed in Bavaria, where the natural increase was larger among the Jews than among the christians in 1876, when a decline began to be noted among both groups, but with a much greater severity among the Jews than among the christians.

	Jews	Christians
1876	15.8	14.1
1880	12.9	10.8
1885	9.9	10.0
1890	6.0	8.8
1895	4.8	12.4
1900	4.6	12.6

The excess of births over deaths among the Jews has thus dwindled to less than one third in Prussia since 1822, and in Bavaria to a little over one third since 1876. This decline in the natural increase of the Jews is not only characteristic of western European Jews, but is also beginning to be noted in eastern Europe. In Hungary, where the rate was among the non-Jewish population only 9.69 during 1891–95, and with slight fluctuations rose to 10.68 in 1903, the tendency among the Jews was decidedly in the opposite direction. It was 17.79 during 1891–1895, and sank to 16.07 in 1901 and even to 14.90 in 1903. The same conditions are observed among Jews in other European countries.

V. *Summary and Conclusions*

The demographic facts presented in the preceding studies lead to but one generalization: The birth, marriage and death rates of the Jews may be taken as an index of their social, economic and intellectual conditions. Wherever they are isolated by hostile legislation, compelled to live apart from the general population, confined in Ghettos, thus deprived of every opportunity to enter into intimate social intercourse with christians; wherever, largely as a result of this isolation, they are on a low economic and intellectual standard, their birth and marriage rates are high, their death rates, particularly the infant mortality, correspondingly high, and practically no intermarriage with christians takes place. Hostile legislation against the Jews is shown, by the evidence presented above, to utterly fail in its aims. Repression of the Jews in countries like Russia has mainly one object in view: To make their life so miserable and unbearable as to induce them to adopt christianity, which removes all disabilities. How far this policy fails in its aims can be seen from the fact that conversions

of Jews to christianity are comparatively rare in Russia and Roumania, while, in common with all others who are on a low social and economic level, their natural increase, *i. e.*, the excess of births over deaths is enormous among them. They increase in number in spite of the attempt to check them. This is substantiated by the statistical evidence gathered from the censuses of Russia, Roumania, Poland, Galicia, etc.

On the other hand, in western Europe, in Germany, Italy, France, England and in America, where the Jews are enjoying civil liberty on an equal basis with the general population, and where they are, as a result, on a superior plane socially, intellectually and economically, their birth and marriage rates are so low, that even with phenomenally low death rates there is left a very small excess of births over deaths, in fact they show a striking retrogression and decadence. This decadence is by no means accidental, but can be traced as due to the remarkable development they have been undergoing during the last seventy-five years, and also to the social intercourse with gentiles which in addition also brings about mixed marriages. The children born to these mixed couples are lost to the Jews, less than twenty-five per cent., and there is good reason to believe that hardly more than ten per cent. remain Jews, while the rest is net gain to christianity. On the whole, the native Jews in western Europe and America are being decimated by a low birth rate, and absorbed by intermarriage with christians. Any increase in their number is due to immigration from eastern Europe.

The demographic facts presented by the Jews may also be taken as an index of their religious status. In the orient and in eastern Europe, where the devotion to their faith is intense, they have high birth rates, early marriages, substantial excess of births over deaths, and no intermarriages with christians occur. In western Europe and in America conditions are different and go hand in hand with an evident lessened intensity of faith, often amounting to religious indifference. In fact, the cruel persecutions and massacres to which they were exposed during the last two thousand years have not robbed the Jews of as large a proportion of adherents as modern emancipation with its concomitant adaptation of the habits and customs of modern civilized life. To take Russia as an example. There the Jews are oppressed mainly with one aim in view: to gain them for the Greek orthodox church. As soon as he adopts christianity, the Jew, besides receiving a bonus of thirty silver roubles, is also given all the rights enjoyed by the christian population. But notwithstanding all these tempting advantages offered, less than 90,000 Jews were converted during the nineteenth century. In contrast with this may be taken Prussia, where the number of Jews is only 392,322 (1900) as against about 5,500,000 in

Russia. Here, according to J. de la Roi, as many as 13,128 Jews have been directly converted to christianity during the nineteenth century, and since mixed marriages were legalized in 1875, 10,160 Jews married christians; in Russia no such marriages have taken place, except of those who adopted christianity and are included among the converts. In Russia the birth rate was 35.43 in 1897, not much lower than in the beginning of the last century. On the other hand, in Prussia the rates were high in 1822–40—35.46—but kept on sinking since their emancipation, reaching 18.71 in 1904. In other words, if the Jews in Prussia had remained in their original civil condition, unaffected by modern conditions of life, they would have maintained their birth rates as the Jews in Russia, and the number of children born during 1904 would have been about 13,000 instead of 6,913, as was the case. During the thirty years, 1875–1904, there occurred altogether 267,775 births by Jewish mothers in Prussia. If they had maintained their birth rates at 35 per 1,000, the number born would have been about 385,000 during that period. The decline in fertility has consequently caused a loss of 117,000 to the Jews, and if to this are added the large number of conversions and of mixed marriages, which have taken place in that country during these thirty years, it is evident that the total loss sustained by Judaism was larger in Prussia where there are less than 400,000 Jews, than among the 5,500,000 Jews in Russia during the entire nineteenth century.

The results of these conditions are seen when the relative number of Jews in Germany is considered. In 1861 there were 138 Jews to 10,000 christians; in 1900 the number sank to 114, and the last census taken in 1905 shows another decrease—there are only 109.8 Jews to 10,000 christians. The same has been the case with the Jews in other German provinces, excepting Saxony:

NUMBER OF JEWS PER 10,000 CHRISTIANS

	1870	1900
Germany	125	104
Prussia	133	114
Würtemberg	67	55
Bavaria	104	89
Baden	176	140
Hessen	297	219
Saxony	13	30

Although there was a large emigration of Germans who left for America and for German colonies, still there was an enormous increase of population in that country. In contrast with this increase are the Jews in that country: although very few emigrated within the last thirty years, and many Jews from other countries have immigrated to Germany, still they have not kept pace with the general increase of

population, and in fact show a relative decrease in number. And judging by the fact that the birth and marriage rates keep on decreasing, while the mixed marriages and conversions to christianity keep on increasing in number, as was shown in the preceding articles, the future of Judaism in Germany is, to put it mildly, not very bright. The same process of decadence is observed among the Jews in Italy, France, England, America, etc., in varying degrees of intensity. If immigration of Jews from eastern Europe should for some reason cease, the number of native Jews in these countries would dwindle away at a rate appalling to those who have the interests of their faith at heart. In the United States the original Jewish settlers, the Spanish and Portuguese Jews of the seventeenth, eighteenth and the first half of the nineteenth centuries who refrained from intermarriage with their German and Polish coreligionists, have practically disappeared; very few of them have been left. The Jews are thus paying a high price for their liberty and equality—self-effacement.

Another important conclusion we arrive at while studying the above facts and figures is that most of the demographic phenomena are not rooted in ethnic causes. The high rates of proliferation, the exclusiveness of the Jews manifesting itself in part by endogamy, the alleged excessive proportion of male births, the rates of suicide, etc., were all attributed to racial influences, to 'Semitic' characteristics. This opinion has its origin in the observations on Jews made during the eighteenth and first half of the nineteenth centuries, when the Jews all over Europe were a homogeneous social mass, all to the same extent abused, persecuted and confined in Ghettos. Uniformity of social conditions brought about uniform demographic phenomena, which were considered racial traits. But the emancipation of the Jews in western European countries, releasing them from isolation, bringing them into intimate contact with their non-Jewish neighbors, has completely transformed them. Racial traits are not to be obliterated by a change of *milieu* during a comparatively short period of fifty or one hundred years, nor do they show such wide limits of variation as is displayed by the Jews in different countries. There are to-day more pronounced differences between the Jews in Prussian Poland and Russian Poland than between Prussian and Italian Jews, although but one hundred years ago the Prussian and Polish Jews were demographically on the same level. The part of Poland which was taken by Prussia with its liberal government has given the Jews an opportunity to assimilate with the christian population, while in the part of that country taken by Russia they were compelled to live isolated from the general population and they remained backward.

The demographic phenomena of the Jews are rooted in the social, economic and intellectual conditions in which they find themselves.

NOTES ON THE DEVELOPMENT OF TELEPHONE SERVICE. III.

By FRED De LAND
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VI. *First Commercial Telephone Exchange*

THE first commercial telephone exchange system in the world was opened in New Haven, in January, 1878, and has been in continuous operation ever since. This pioneer exchange was organized by Mr. George W. Coy, who now resides in Milford, New Haven County, and who, during the twelve years ending with the year 1877, was managing the local offices of the Atlantic and Pacific and the Franklin Telegraph companies.

In July, 1877, the local papers in New Haven contained an advertisement of 'Bell's telephone' reading in part:

> The proprietors keep the instrument in repair, without charge, and the user has no expense except the maintenance of the line. It needs only a wire between the two stations, though ten or twenty miles apart, with a telephone at each end. . . . The outside of the telephone is of mahogany finely polished and an ornament to any room or office. Telephones leased and lines constructed.

In September, 1877, Mr. Coy secured several Bell telephones and installed a few private lines in New Haven, and also displaced some district call-boxes with telephones in his local messenger service. Perceiving how useful the telephone was proving to business houses desiring his messenger service, Mr. Coy concluded that a central telephone exchange system would be a desirable thing for the community, provided a sufficient number of subscribers could be secured.

Now in the beginning of the evolution of telephone exchanges, there was neither experience nor knowledge to guide the investor or the manager. There were no known methods of operation or of maintenance to render uniform and no equipment to standardize, because the to-be equipment had yet to be evolved from needs then unknown. The Bell company had no factory and supplied only the hand telephones, which were made to order under contract. Thus each licensee was largely thrown on his own resources and compelled to devise much of his exchange equipment and to secure from several different sources such associated apparatus as was available. Then the installation was necessarily made and the lines run with the aid of the telegraphers of that day. For in 1877–8, the only 'electricians' were the men associated with the telegraph companies. The electric light and the trolley then had no commercial existence. Thus, through the needs of the telephone exchange, was evolved that now very essential person the

'telephone engineer.' That is why Mr. Coy had not only to plan his own central exchange system, but also to devise the necessary switching mechanism for his central office.

Confiding his plan to his friend, Herrick P. Frost, the latter agreed to assist Mr. Coy. Not that Mr. Frost knew aught about the telephone or telegraph, but because he wanted to make a place for his son, then about sixteen. Neither Coy nor Frost could spare the funds necessary to build the exchange system, so Mr. Frost borrowed six hundred dollars from his brother-in-law, Walter Lewis, organized the New Haven District Telephone Company, secured a charter, and issued capital stock having a par value of five thousand dollars. Of this amount Coy and Frost subscribed for $2,000 each and $1,000 was transferred in November, 1877, to the parent Bell company for a license granting the exclusive right to use Bell telephones in the counties of New Haven and Middlesex, in Connecticut. Mr. Coy states that later this block of stock given to the Bell Company was repurchased by the treasurer of the company for two hundred dollars in cash.

By virtue of his services as the good angel so essential in pioneer undertakings, Walter Lewis was elected to the presidency of the company, Mr. Frost was made treasurer and Mr. Coy filled all the other offices. Morris F. Tyler was the company's attorney, secured its charter, obtained the necessary additional loans to enable extensions and improvements to be made, took his pay in stock, and later became the head of the organization. Incidentally it may be added that on May 31, 1878, Mr. Frost secured exclusive licenses to use telephones under Bell patents for the term of ten years, in the cities of New Haven, Hartford, Meriden, Middletown and New Britain, in Connecticut, and of Springfield in Massachusetts, subject to his leasing not less than five hundred telephones the first year, and expending not less than $8,000, including the amount already expended in New Haven.

Being ready to proceed with the installation of its 'telephone-call system,' Mr. Coy mailed to the prominent citizens of New Haven a thousand copies of a circular describing the many advantages the system would offer, and earnestly requesting subscriptions for the service. It was expected that at least fifty replies would be received, but only one subscription was obtained, and to the late Rev. John E. Todd, pastor of the Church of the Redeemer, belongs the honor of being the first person in the world to subscribe for the service of a commercial telephone exchange system. Quite rightfully Mr. Todd's name headed the first list of telephone subscribers ever issued.

So complete a failure to arouse public interest in the telephone system was a bitter disappointment to Mr. Coy. But being a born hustler, he immediately sent out a competent canvasser to solicit contracts. This agent succeeded in ultimately securing over two hundred

contracts, for which he was paid a commission of one dollar each. The first contract thus secured was that of the New Haven Flour Company for five telephones, including one in each of its stores and one in the residence of its manager, Mr. George E. Thompson.

Mr. Coy commenced installing the telephones in November and it was his intention to have had his exchange in operation early in December, 1877, but so numerous were the mechanical difficulties that had to be overcome, so many electrical problems required solving, and so slow were the shipments of telephones, that it was not until January 28, 1878, that the exchange was formally opened, the first service being given on January 21, to about thirty subscribers.

Following the formal opening, the number of subscribers increased rapidly, and on February 21, 1878, appeared the first regular list of subscribers to a commercial telephone exchange. Fifty stations were listed. The second list appeared on March 9, 1878, less than three weeks after the first, and recorded about one hundred and twenty-five stations. On April 8, 1878, came the third list with two hundred and twenty-seven subscribers, including forty-two residences. Thenceforward there was a steady growth. In all these lists names only were shown. Numbering the subscribers to facilitate rapidity in securing connections was an afterthought. Even so late as April, 1880, and in so important a city as New York, the list of subscribers contained no telephone numbers, though there were about one thousand five hundred names distributed through six exchanges.

The rates established by Mr. Coy were only eighteen dollars a year for a telephone in either the office or the house. But it should be borne in mind that the circuits were of single iron wire and grounded, and that from ten to sixteen subscribers were on a line, a number that would not be tolerated in modern business service. Like many modern telephone men, Mr. Coy did not base his rates on what he thought the service was likely to cost him, for the eighteen-dollar rate was established before a pole had been erected, but on what he thought the public would pay. In January, 1877, the American District Telegraph Company introduced a rate of eighteen dollars a year for its call-box system in New Haven and cities of similar size, while it charged thirty dollars a year in the large cities. So Mr. Coy concluded he could supply a telephone as cheaply as a district-box could be furnished; and that is how the eighteen-dollar rate came to be established. Thus, as early as February, 1878, Mr. Coy was advertising in the local papers that 'the company rents them at the extremely low price of five cents per day, thereby placing telephones within the reach of all.' And on February 14 it was stated that Mr. Coy was 'supplying telephones in any part of the city, including service to Fair Haven and Westville (separate boroughs, one four miles, the other seven miles distant) for

eighteen dollars per annum.' And it may be added that the gross receipts of the New Haven exchange in the month of February, 1878, were $250.

Mr. Coy was a great believer in press publicity and made liberal use of the advertising pages of the local papers, thus keeping the public informed concerning all extensions and repairs. In those days the weather reports issued by the United States Signal Service were very desirable. So Mr. Coy placed a telephone in the office of the weather observer, and on March 15, 1878, advertised that 'any one having a telephone can make inquiries as to the weather, temperature, barometer, etc.' A little later Mr. Coy built a pole line nearly seven miles in length and ran a circuit to the lighthouse at the east end of the harbor, thus benefiting shipping interests by the prompt transmission of cautionary weather reports, and also enabling his subscribers to keep track of the arrival of steamers and other marine craft.

On May 1, 1878, Mr. Coy had telephones 'placed near the targets,' and also 'at the shooting-stand,' connecting the latter to the central exchange, thus enabling his subscribers to keep informed concerning the scores made at the annual meeting of the rifle association. Another feature that is considered essentially modern was introduced in New Haven by this company. On November 4, 1878, it advertised that "in order to facilitate the collection of election returns from the different wards in this city, to-morrow, the company has made arrangements for placing a telephone in or near each voting place, in order that the returns may be sent to the central office as soon as declared. The returns will be furnished to any subscriber upon inquiry by telephone." Later the daily papers stated that 'the telephone was of great use in collecting and transmitting election returns.'

During the first two months Mr. Coy's exchange occupied one half of a ground-floor store room in the Boardman building, corner Chapel and State Streets, New Haven. This room then bore the number 219 Chapel Street, but is now 733. Then the exchange was moved to the top floor of the Ford building, directly across Chapel Street; but the office of the company remained in the Boardman building.

Until March 1, 1878, service was given only from 6 A.M. to 2 A.M., the night operator remaining on duty until that early morning hour in order that the newspapers might have telephone service up to the hour of going to press. For newspaper reporters quickly realized what a blessing the telephone was in accelerating the transmission of a scoop, or a good story, or a simple news item, and utilized the service on every possible occasion.

Prior to 1877, if anything happened at a point distant from a telegraph office, and branch telegraph offices in cities were few and far between in those days, reporters were in the habit of gathering the

names of the participants and the essential facts, and then hastening with all possible speed to the editorial rooms. Late at night few horse cars were running (then the trolley-car was unknown), and rarely was it possible to secure cab or carriage on the scene of action; so getting a good story often meant a long, steady trot for many blocks before the editorial rooms were reached. To-day a reporter can prepare his copy on the premises, walk to the nearest telephone, talk it to an assistant in the editorial rooms who typewrites it as it comes over the wire, and the 'scoop' or 'story' is on the street in less time than the reporter of 1876 would have consumed in riding or running to his office. And with the aid of the telephone, the city editor in the large cities often makes many assignments without seeing the respective reporters for days at a time. In fact, in the larger cities, certain reporters now communicate by telephone with the editorial rooms every half hour while on duty, and only visit the main office to draw their salaries.

After March 1, continuous day and night service was given. During the first week one boy operator, Louis H. Frost, son of the treasurer, was the sole operating force; then Julian Cramer was added; on March 1 Fred A. Allen was employed; and later came Charles W. Dow. The night operator received a salary of $15 a month, and worked from 5 P.M. to 8 A.M. Incidentally it may be added that Mr. Allen and Mr. Dow are still employed in the New Haven telephone exchange, and that Mr. Frost is in the livery business in that city.

In building his subscriber-lines, Mr. Coy erected very few poles during the first four months. The grounded-iron circuits were supported on brackets fastened to the sides and roofs of buildings, and to trees, the owners of the property usually making no charge for this right of way. Owing to this method of suspension no two spans of wire were the same in length, and slack wire was in evidence the year through. Hence, it was only natural that the talking qualities of these circuits should never be very good, and invariably be very low whenever these wire festoons were swayed by the wind against tin roofs, or were grounded on wet roofs or on the dripping branches of trees.

Thus it naturally came about that on drizzling days the amount of shouting required on the part of subscribers striving to carry on a conversation with the aid of a single hand telephone was a source of much amusement to non-participants, and a probable cause of much profanity and ill-feeling to many users of the service. And all the blame was placed upon the little wooden telephone in place of the wretched construction and the circuits that were constantly being crossed or grounded on wet roofs or on the branches of trees. Had these early lines been built with all the care and under the engineering supervision now expended on the heavy copper metallic circuits,

excellent talking service would, no doubt, have resulted. For there were few vagrant currents sneaking around in those days.

Yet back to these cheaply constructed subscriber-lines and that crude equipment is easily traced the origin of the marvelous system of intricate switchboard mechanism, practical and standardized methods, and progressive operation known as the modern telephone exchange, and by the aid of which a subscriber in New Haven may now talk with greater ease to a subscriber in Pittsburg, or in Chicago, than was possible when the two subscribers were distant only a block away on wet pioneer days in Connecticut. That is, less shouting would be required.

With the accumulation of experience in constructing telephone pole lines covering a period of a quarter of a century, we might wonder that Mr. Coy should have put up telephone lines of so crude a character. But from whom could he gain experience concerning the construction of telephone lines? He built the first commercial telephone line ever constructed. Owing to the bitter competition existing between the telegraph companies, the telegraphers of those days strove not to see how good a telegraph line could be built, but how cheaply it could be constructed and yet carry messages when 'sufficient battery' was used. Battery current cost but little, and properly-constructed pole lines brought no higher price than rickety lines, when the inevitable consolidation was brought about by cut rates. Then the promoter pocketed his profit, and the public footed the bill in an increase of rates to cover interest charges on the duplicate and non-earning investment. In the words of a governmental report dated January, 1869:

> There is no uniformity in telegraph rates. They are often less to a distant (competing) station than to an intermediate one on the same line. In other countries the rates are reduced with the growth of business and never raised. In this country they are reduced by competition, followed by consolidation of the competing companies, and subsequent increase of rates, without regard to the growth of the business.

Yet Mr. Coy followed the approved American practise of 1878, a practise that prevailed for several years thereafter, as is evident from the official instructions issued by the parent Bell company during the years 1879–81. And these instructions certainly make interesting reading, now that uniformity in methods and standardization in equipment and stability in construction are rigidly insisted upon by all legitimate telephone companies.

It was comparatively easy to run telephone circuits in those pioneer days when only telegraph or signal companies were stringing wires.

There were no trolley wires until 1884, and no central station lighting plants prior to 1879. In 1873 William Wallace was building his relatively large magneto-machines in Ansonia, which early in 1874

were connected up and used as dynamos in lighting his factory. In 1875 he brought out a more compact dynamo that 'was in operation furnishing current for electric lights in Machinery Hall during the entire period of the Centennial.' In 1877 two Brush 'dynamos built for lighting were exhibited and tested at the Franklin Institute in Philadelphia,' with a 'ring-clutch' arc lamp. The first Brush 'dynamo and lamp actually sold were shipped to Dr. Longworth, of Cincinnati, about January, 1878,' and installed by Charles F. Brush. In April, 1879, twelve Brush lamps were installed in Cleveland for street lighting, and 'on December 20, 1880, Broadway, New York, from Fourteenth to Twenty-sixth street was first lighted with fifteen Brush lamps.' The first Edison central station was opened in New York on September 4, 1882.

Ten years after the opening of the first telephone exchange central electric-lighting stations were in operation in all principal cities. Of electric railways, in the beginning of 1887, in the United States 'there were only ten installations with an aggregate of less than forty miles of track and fifty motor cars, operated mostly from overhead lines with traveling trolleys.' The principal practical pioneers were Charles J. Van Depoele who built an experimental trolley system in Chicago in 1882–83; Leo Daft who, a year later, operated an experimental electric locomotive at Saratoga; Bentley & Knight who placed an experimental conduit system in operation in Cleveland, in August, 1884; J. C. Henry who completed the trolley system in Kansas City in 1884–85, and Frank J. Sprague's experiments in 1885.

FOSSIL INSECTS AND THE DEVELOPMENT OF THE CLASS INSECTA[1]

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TO the majority of mankind, who supposedly are inclined to look on the bright side of life, the sound of the word 'insects' ever recalls the picture of a wide-awake boy with a green net and possibly with a botanical box of the same hue, but more vivid in color, chasing along after the variegated butterflies and beetles. He seldom overtakes them, but positively assures us that he already has a 'nearly complete collection of insects of fifty or more species.' With this same word 'insects' many a pessimist, however, will bring to mind only the small troublesome pests of his home, perhaps even of his own worthy person, or certain minute organisms to which he indirectly ascribes the cause of the more and more frequently recurring adulteration of his wine. In each instance, the matter will be quickly despatched either with a good-natured smile or with a gentle imprecation, and only rarely does *Homo sapiens* attempt to make clear to himself what the word 'insects' really signifies.

That insects constitute a subdivision of the Arthropoda, to which group spiders, crabs and myriapods also belong, and that they are distinguished by the possession of only six legs and four or two wings, have with other details doubtless been acquired at school, where, too, knowledge was surely gained of many forms because of their usefulness (bees and silkworms) or because of their injurious character (moths, bark-scarabs and plant-lice).

Of the immense part that insects play in the household of nature and especially in science, however, of their truly wonderful diversity in bodily structure, of their organization, habits of living and development, as well as of the number of species, the greatest ignorance still prevails everywhere.

In proof of this not too flattering assertion, therefore, we will at once proceed to give a statistical summary, strictly in round numbers, of the insects now existing and scientifically recorded and named.

About 3,000 species of grasshoppers and crickets (Locustidæ and Gryllidæ) are known, whose music fills the woods and meadows of both

[1] Translated from the German by Lucy Peck Bush, Peabody Museum, Yale University. (Mitt. d. Sect. f. Naturk. d. Osterreich. Tour.-Klub, April, 1905, pp. 25–30.)

hemispheres; and about 4,000 species of their nearest relatives, the locusts, or Acrididæ, to which group the notorious migratory locusts also belong. It is estimated that there are about 2,500 kinds of specters, or walking-sticks (Phasmidæ), which inhabit tropical regions chiefly and are noted for their close resemblance to twigs and leaves. Much smaller is the number of those creatures called earwigs, although they are neither worms nor crawl into the ears; scientifically they are termed Dermaptera, and comprise about 500 species. Less noteworthy are the 200 forms of small thrips, or Physopoda. The stately, but harmless, praying-crickets, or Mantidæ, are represented throughout the world by only 800 different species. On the other hand, about 1,200 kinds of cockroaches, or Blattidæ, are known, and this family unfortunately includes the small Croton-bug and its larger black cousins. In warm countries, with these troublesome creatures are associated about 400 different species of white ants. The very small insects called body-lice, book-lice or wood-lice, which belong to the Corrodentia or Copeognatha, are represented in almost equal numbers. Mallophaga (bird-lice, which should not be confounded with bird-ticks) already number 1,300 species, for nearly every kind of bird has its special parasite. On the other hand, luckily, only 50 species of true blood-sucking lice have become known, a relatively high percentage of which afflicts mankind. One hundred and sixty thousand species is certainly not too large a figure to include the hosts of beetles, or Coleoptera, which people every corner of the globe, and may be obtained in the region of perpetual ice as well as in salt marshes. We are acquainted with but 52,000 species of Hymenoptera, or membrane-winged insects, among which are the many 'wild' relatives of the honeybee, the colonies of ants, the true wasps, digger-wasps, ichneumon-flies, gall-flies, saw-flies, golden-wasps and wood-wasps. Of dragon-flies, or libellids (Odonata), there may be about 2,300 different kinds at present described, while 300 species of May-flies (Plecoptera) and stone-flies (Perlidæ) are recognized. True Neuroptera (netted-winged insects), which also include the ant-lions and lace-winged flies, number 1,400 species; Panorpidæ, or scorpion-flies, about 100, and caddice-flies, or Phryganeidæ, 1,200. After the beetles, the forms most abundant in species are the butterflies, or Lepidoptera; of these science has disclosed the existence of about 55,000 species up to the present time. Next come the much less noted two-winged insects, or Diptera, of which two main groups, Orthorrhapha (midges, gnats, horse-flies, etc.) and Cyclorrhapha (true flies), with 14,000 and 30,000 species, respectively, share in the sum total of insect forces. The number of fleas, or Suctoria, is small in comparison, only 100 species as yet being known, one of which lives on the blood of mankind. Further, if the 30,000 kinds of bugs, cicadas and plant-lice included in the Hemiptera,

or half wings, are counted, the round sum of 360,000 species of insects now known is reached.

Estimates have been given showing that not more than one sixth of all forms actually existing have as yet been described and named, so that the number of species (not individuals) now living in the present period of the earth's history may be placed at about 2,000,000.

It is quite conceivable that man in his effort to understand nature everywhere surrounding him should not be satisfied merely to study all these existing insects and arrange them in a system of orders, families, genera, etc., but he would also wish to know how this greatest division of the animal kingdom, in specific numbers about doubly exceeding all other groups, has been developed, and how and when it has attained its present size.

If we would really learn the primitive history of the insect tribe, and not construct it in a speculative manner, we must descend into the depths of the earth in order to see whether or not a fortunate chance has possibly preserved some remains which might afford us an insight into the insect life of previous ages.

If, as mentioned above, the number of various species of insects now existing be taken in round numbers at 2,000,000, and for each species at least 1,000,000,000 individuals yearly, which, judging from the swarms of bees and gnats, colonies of ants and termites, parasites of plants (often millions living on a single tree), certainly seems legitimate, an annual total of 2,000,000,000,000,000 (two thousand trillions) individuals is obtained, while during the time that man has inhabited the earth some hundreds of trillions must have existed.

And of all these trillions of insect remains, which moderately computed (about 100 to a gram) represent 1,000 billion kilograms in weight, we have as yet found but a few hundred examples, and these have been accidentally enclosed in gum (copal), in peat-beds, or finally buried in hardened mud. They have thus become more or less well preserved, and again by chance have fallen into our hands. All these forms clearly demonstrate that the species of insects have not materially altered during man's sojourn on the earth.

It may now be concluded that these results must lead only to discouragement, for they show very plainly how small a percentage of the insect world escapes complete destruction, and how slight is the prospect of securing any of these remains.

Notwithstanding this, it has already come to pass that quite a number of fossil insects have been brought to light from analogous deposits of older periods, and the explanation may be partly found in the fact that even these older strata are to be estimated not only by thousands, but probably by millions of years, so that the sum total of vanished and preserved forms must evidently increase accordingly.

Although in comparison with the hosts of living forms, researches hitherto made have resulted in the insignificantly small number of about 10,000 species of fossil insects, yet these few afford us a glimpse into the insect life of past ages. Such a collection of extinct species, moreover, much exceeds in numbers the recent forms in most university and private collections, which have become the basis of so many bold hypotheses. We can thus see or at least have some idea how in the course of millions of years the present mighty tree has grown up from so small and tender a plant.

Of the fossil insects thus far obtained, the larger part have come from that important period immediately preceding the age of man. This is designated the Tertiary period, or the age of mammals. Those insect remains preserved in fossil gum (Baltic amber), like artistic and permanent microscopic preparations, are indeed well known, and of these many thousand specimens have been accumulated in museums. On the other hand, less noted, but not less numerous, are the wonderful impressions found in many places in laminated shales, as in Œningen (Baden), Radoboj (Croatia), in Italy, on the Rhine, in Provence, in North America, etc. These are to be likened to nature's own printing and provide us with an atlas of the Tertiary fauna in which we find very many species that can scarcely be distinguished from those living to-day. With the exception of bird-lice, lice and fleas, all the principal existing groups of insect throngs are represented in Tertiary time, but the remarkable bizarre forms which especially delight our eyes to-day were much fewer in number then than now. Thus very few large butterflies and no striking types of beetles, such as we are accustomed to see in all shop-windows of the dealers, have been discovered.

Even though the character of the Tertiary fauna in general did not vary essentially from that now in existence, still the distribution of forms over the earth must have been far different. For instance, in Germany we find elements that now are met with only in tropical lands, from which follows many a conclusion as to the variations of climate and of the plant world. Moreover, the numerical distribution of species in kindred groups was likewise not the same as that at present in force, since among the Tertiary Hymenoptera a much smaller percentage of bees is found, among the Diptera there are more gnats than flies, among the Orthoptera far more grasshoppers than locusts, and only very few walking-sticks, etc.

Further, when it is stated that in the Tertiary period no single type of insect has been hitherto identified which does not still exist, and that therefore the numerous amber preparations and the impressions so beautifully preserved are as yet capable of giving no direct answer to our question, we must then turn to the next older period,

TABULAR SUMMARY OF THE DEVELOPMENT OF INSECTS IN THE VARIOUS GEOLOGICAL PERIODS

	Number of Known Species Actually Existing.	Tertiary.	Cretaceous.	Jura.	Lias.	Trias.	Permian.	Uppermost Upper Carbon.	Middle Upper Carbon.	Lower Upper Carbon.
Palæodictyoptera (primitive insects, ancestors of all other groups)	0	0	0	0	0	0	0	+	+	+
Protorthoptera (ancestors of the orthopteroids)	0	0	0	0	0	0	+	+	+	0
Orthopteroidea:						?				
Orthoptera (straight wings):										
Locustoidea (grasshoppers and crickets)	3,000	+	?	+	+	?	0	0	0	0
Acridioidea (locusts)	4,000	—	?—	0	0	0	0	0	0	0
Phasmoidea (specters, or walking-sticks)	2,500	—	?—	—	0	0	0	0	0	0
Dermaptera (earwigs)	500	—	?—	0	0	0	0	0	0	0
Physopoda (thrips)	200	—	?—	0	0	0	0	0	0	0
Protoblattoidea (ancestors of the cockroaches and mantids)	0	0	0	0	0	0	+	+	+	0
Blattüformia:										
Mantoidea (praying mantes)	800	=	?	=	=	?	—	0	0	0
Blattoidea (cockroaches)	1,200	=	=	=	=	?	+	+	—	0
Isoptera (termites)	400	=	?	0	0	0	0	0	0	0
Corrodentia (wood-lice or body-lice)	400	=	?	0	0	0	0	0	0	0
Mallophaga (bird-lice)	1,300	0	0	0	0	0	0	0	0	0
Siphunculata (true lice)	50	0	0	0	0	0	0	0	0	0
Coleopteroidea:										
Coleoptera (beetles)	160,000	=	=	—	—	—	0	0	0	0
Strepsiptera (fan wings)	10	=	0	0	0	0	0	0	0	0
Hymenoptera (membrane wings)	52,000	=	—	—	0	0	0	0	0	0
Mixotermitoidea (extinct provisional group)	0	0	0	0	0	0	0	0	+	0
Hapalopteroidea	0	0	0	0	0	0	0	+	0	0
Hadentomoidea (? ancestors of the embids)	0	0	0	0	0	0	0	0	+	0
Embioidea (embids)	50	+	?	?	?	?	?	0	0	0
Perloidea (stone flies)	300	+	?	+	?	?	+	0	0	0
Protodonata (ancestors of the odonatids)	0	0	0	0	0	0	+	+	—	0
Odonata (libellids)	2,300	=	?	+	+	?	0	0	0	0
Protephemeroidea (ancestors of the plectopteres)	0	0	0	0	0	0	0	+	0	0
Plectoptera (ephemerids, or May-flies)	300	=	?	+	?	?	+	0	0	0
Neuropteroidea (netted wings)	1,400	=	?	+	+	—	0	0	0	0
Megasecoptera (ancestors of the panorpoid series?)	0	0	0	0	0	0	?	+	—	0
Panorpoidea:						?	?			
Panorpata (scorpion-flies)	100	=	?	+	+	?	?	0	0	0
Phryganoidea (Trichoptera, or caddice-flies, etc.)	1,200	=	=	=	=	0	0	0	0	0
Lepidoptera (butterflies)	55,000	—	—	—	0	0	0	0	0	0
Diptera (two wings):										
Orthorrhapha (midges, gnats, horse-flies, etc.)	14,000	+	?	—	—	0	0	0	0	0
Cyclorrhapha (flies)	30,000	—	?	0	0	0	0	0	0	0
Suctoria (fleas)	100	0	0	0	0	0	0	0	0	0
Protohemiptera (ancestors of the half wings)	0	0	0	0	0	0	+	0	0	0
Hemiptera (half wings)	30,000	=	=	=	—	?	—	0	0	0

The signs +, —, = denote that, compared with the same group as now existing, a group falling in a given period was relatively more abundant, smaller, or equally developed, respectively, in the next younger period.

the Mesozoic, or the age of reptiles. Of its three chief divisions, Cretaceous, Jurassic and Triassic, the first mentioned and youngest has thus far yielded only a small number of fossil insects. During the Cretaceous, the flowering plants came into existence, and on this account it may be concluded that a multitude of new conditions were furnished for many kinds of insect forms. The bees and various other honey-eaters could thus have originated. The fact that insects immediately adapted themselves to these new plants is to be seen in the few specimens thus far obtained; that is, in the galls and eaten places on the leaves of the oak, willow and Eucalyptus, etc. Other than these, unfortunately, but little evidence of insects has been found in the Cretaceous.

On the contrary, the remains of this group preserved in Jurassic deposits are very large in number. These have been discovered in England, Spain and Russia, but nowhere in such quantities and remarkable preservation as in the Jura of Franconia in northern Bavaria, where in previous epochs a shallow sea between coral reefs became filled up with the finest calcareous silt. Many of the insects which peopled the neighboring land found their graves in this mud. By a fortunate chance, after perhaps millions of years, these forms have now come to us, for this same hardened mud is to-day used by us as lithographic stone or paving-stone.

Now what does this rich collection of Jurassic insects teach us? It shows that in that period probably an entire series of groups of living forms either then had no existence or were just in the process of evolution. As yet are found no locusts, no earwigs, termites, thrips and wood-lice. Of the Diptera, the only representatives are those which are in the minority to-day; of the Hymenoptera, the wood-wasp, saw-fly and ichneumon-fly alone appear to have been present, while bees, ants, etc., are wanting. Some primitive forms of butterflies have been discovered, but these were at first erroneously regarded as cicadas. Grasshoppers were abundantly developed and some of them, judging from the structure of their legs, may have run about on the water or wet mud quite as water-striders, a genus of aquatic insects, do at the present time. Through their changed habits of living, these water locusts thus appear to have modified the legs no longer needed for jumping, and in this way the specters, or walking-sticks, may have finally originated. Dragon-flies, May-flies, Neuroptera and Hemiptera were represented in great variety, and of the last group there were aquatic species as well as those terrestrial; also small cicadas. Beetles, too, were not wanting, although no particularly striking forms are to be distinguished.

The fact that Jurassic insects were so extremely abundant clearly indicates a warm climate, and the school children of Bavaria would

have to provide themselves with much larger nets should the thousands of past generations of insects celebrate a joyous resurrection, for the size of these Jurassic representatives was from four to five times that of many forms now existing in the Danube region.

But these fertile years were apparently preceded by others more barren. At least this impression is gained when we contemplate the swarms of insects that lie buried in a stage still lower—the Lias, or black Jura. The discovery of some rich localities in Switzerland, in Mecklenburg and in England, for instance, have yielded almost absolutely dwarf species. On the average, these forms were even smaller than those inhabiting the same regions to-day; truly starved species. In fact, at that time there were as yet no butterflies, few Hymenoptera, and no other striking insects. The beetles and gnats found were small and insignificant. On the other hand, caddice-flies and scorpion-flies were abundantly represented, the latter of which now play only a limited part. There were also dragon-flies of moderate dimensions, bugs and small cicadas similar to our frog-hoppers; grasshoppers and locusts, and the ever-present cockroach as well.

From the long Triassic period that stored up a large part of the material from which the imposing dolomite towers were subsequently formed, we as yet unfortunately know only some insignificant beetles and Neuroptera. Hence, we can turn at once to that very ancient period called the Paleozoic. On important but purely material grounds, this epoch stands very close to mankind in general, since it includes the most valuable coal deposits, the mining of which has materially aided our present studies. In and near the coal in many places in Europe and North America has been found a great number of impressions of insects whose investigation furnishes us with an entirely new world of forms.

Although in the upper beds of this period no more beetles and Neuroptera are found, yet caddice-flies and scorpion-flies, gnats and locusts, too, are wanting. So much the more do the cockroaches increase! May-flies and stone-flies were already represented, and Hemiptera as well, but of a form that it is not known whether they should be pronounced cicadas or bugs.

In addition we also find insects that it may not be possible to arrange in the established classification of living forms, although affinities with the latter are undoubtedly to be recognized. The deeper we descend into the coal period, these forms more and more increase in number, while modern types gradually become less and less frequent. It may therefore be concluded that in the Carboniferous forms the direct ancestors of many of the insect groups previously mentioned are to be sought, and hence corresponding names have been chosen for them: as Protodonata, the ancestors of the Odonata, or libellids;

Protorthoptera, ancestors of the Orthoptera, or locusts, etc. Nearly all these insects attained a considerable size; indeed, there were many the span of whose wings measured much more than half a meter—they were literally giants!

These forms, too, decrease in number, and at last there appears to us a quite distinct fauna of primitive creatures, whose structure was of the simplest order, and who were apparently without adaptation to the definite modes of life which we are accustomed to see in nearly all existing insects. These primitive forms we call 'Palæodictyoptera,' and among them it is possible to distinguish a series of different genera and species, all, however, having common characters and standing in about the same degree of relationship to existing groups.

These palæodictyopteres, therefore, constitute the first shoot of the giant tree which we have to-day in the insect world.

As has been frequently indicated, we also see that the race of insects has by no means remained unaltered since primitive times, but that it has been subjected to precisely the same changes as have other groups of animals. And the conclusions to be drawn from these mutations are manifold. In the first place, they permit us to erect a natural system in accordance with actual descent; they permit us to weigh the characters accurately and to distinguish between those which are old and inherited and those that are recent and acquired. Moreover, they afford us many and far-reaching conclusions regarding the climate and the nature of the soil in those times and regions, as well as the distribution of land and water, etc. Finally, by this means we are also enabled to penetrate a very little into the future. And this further shows us that eventually neither the boy with the green net nor the imprecating pessimist will be so very far wrong, for the immediate future probably belongs to the brilliantly colored insects, on the one hand, and, on the other, to the troublesome and offensive vermin, the parasites of man, animals and plants. These two extremes appear to us to-day in their greatest development.

NATURE NAMES IN AMERICA

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WHEN Adam, or the cave man, began giving names to the things of the earth and the things of the sky, it was probably with a view to a better personal acquaintance with the objects and for a ready means of conjuring up their images to the mind. In the same spirit a learned professor later defined a system of classification as a series of pegs to hang ideas on. If we are of a mind with Juliet as to the matter of calling a rose by any other name, we accept an undeniable fact, a scientific proposition, but we are at the same time in danger of losing a certain flavor and zest of life, a subtle something in our conscious relation to the things of this world. At least this is true of those of us who are highly endowed with a sense of the fitness of a name for the thing that it stands for. It is more than likely that the man or woman possessing this keen relish for a name will unhesitatingly repudiate the statement of Juliet, preferring rather to live in the delightful delusion of the name itself. It is the conjuring up the image of the thing, the making it a part of the inner conscious self, that has so much to do with the background of our happiness. How could it be otherwise in this age-long association of words and things? Our life is a life of words, and whether we see the printed word, or hear it spoken, it is to us one with the thing itself, and the thing itself is but the word materialized.

This delight in a word for the sake of its associations, though intensely personal, is after all in a large way a matter of race history. What we call the 'mother tongue,' an expression that in itself suggests the most vital relation in human life, is the handing down of inherited speech; as important in its way as the transmission of blood and of brain cell. As the bodily substance may change under the influence of new environments, so a language may change under like conditions, and yet each will bear throughout its structure the large features of its ancestry. It is a matter of some interest to trace out the effects of the new world on the thought and speech of the early colonists and the incorporation of any changes thus wrought into the language of the people. In pursuing this inquiry I have directed my attention to the names imposed by the settlers on the natural features of the land and the more familiar living objects, such as plants, mammals and birds. These were obvious features in the physical environment, a knowledge of which was often of the first moment to the pioneer, and

their names stand for a certain attitude of thought toward things more or less familiar or things entirely new and strange.

The English stock that colonized the greater part of the Atlantic seaboard of North America, very early left the marks of its language on hill, valley and stream, and on fauna and flora. What objects it did not designate with old world names were called by the names known to the aboriginal peoples—Indian names—usually much altered phonetically. In some instances names were invented directly as expressive of some notable characteristic, and, again, some few were borrowed from the languages of alien settlers. A very large proportion of the names of natural objects in America are transplanted old world names, a fact not at all surprising when we consider the general similarity in topographical features and in the life forms, both plant and animal, of eastern North America and western Europe, notably England. A comparison of the forest trees of North America with those of western Europe shows that a large proportion of the various kinds are common to both sides of the Atlantic. The settlers found much the same aspect of woodland that they had known at home. There were oaks and beeches little different from those of Europe. The same was true of the pines, firs, spruces and larches, and of the birches, alders, aspens and poplars. The maple, elm, ash, plane tree, chestnut, walnut, cherry, hazel and dogwood were broadly recognized as familiar trees, though differing somewhat from their transatlantic representatives. The comparatively few trees that were entirely strange to the early colonists, as the hickory, sassafras, persimmon, magnolia, buckeye and tulip tree, came to be known, for the most part, by their aboriginal names, though much corrupted both in spelling and in speech. The two last named trees—the buckeye and the tulip —were so called, the first from the fancied resemblance of its nut to the eye of a deer (a true backwoodsman's comparison), and the tulip tree from its gorgeous blossoms. Beverley in his 'History of Virginia' (1705) speaks of 'the large Tulip Tree, which we call a Poplar.' The tree is not a poplar, but belongs with the magnolias, and the compound 'tulip poplar,' frequently used at the present time, is an unfortunate misnomer. The general similarity of the forests of eastern North America and western Europe is the result of certain geological conditions, among which was a once more or less continuous land connection between the northern portions of the two continents, together with a climate that allowed of a very wide dispersal of plants and animals. Among mammals, the bear, wolf, fox, deer, hare or rabbit, weasel, otter, badger, beaver, squirrel and others were recognized as being closely allied to similar old world types. But with the curious racoon and opossum, the colonists knew of no European animals in any way like them, and we find John Clayton, in 1693, naïvely writing of the racoon as 'a Species of a *Monkey*.' Besides

racoon and opossum the Algonquin tongue has given us such words as 'skunk,' 'chipmunk' and 'moose.'

The early colonists, Puritan and Cavalier alike, were in the main English yeomen. They came not from the crowded centers, but from the rural districts, and it matters little from what district they came, all had been in touch with nature in England, and planted deep in their hearts was the love of fields and woods. This was not often expressed, it was too deep-seated a sentiment, but we see its workings in many an old chronicle. It was not what in the modern sense might be termed poetic, though there were undoubted poets among them. It was rather the feeling that an unlettered countryman has—a certain inexpressible love for the soil and the things thereof. The English emigrant to America was too much a part of his surroundings to see nature from the poet's point of view. The modern esthetic cult—the love of the beautiful—was not a portion of his mental equipment. He had the inquisitive and acquisitive qualities of mind, the interest in things for the sake of knowing about them, the attitude of the curious, and, above all, an interest in the practical uses of natural products. With this attitude of mind toward nature he set foot upon the shores of the new world. The surroundings that he had left are best pictured in the rural England of Shakespeare's and of Milton's time. The richly green meadow pastures watered by abundant streams, along the banks of which Walton and his brother anglers loved to loiter in the shade of broad-spreading trees; the rolling uplands and lines of low hills; the deeply ploughed fields and scattered masses of woodland, with here and there a church spire peeping above them; the hedge-rows blossoming with wild flowers and haunted by innumerable song birds; ancient, ivy-mantled towers and drowsy hamlets, with noisy flocks of rooks and daws—these were the elements in a landscape enveloped in the soft atmosphere of an English sky, and with all the endeared associations of home, that the emigrant carried in his mind and heart to America. Little wonder that he sought in his new surroundings for something to remind him of this old home. The forbidding, untrodden wilderness hemmed him in on every side. The puritan found a rugged land and a harsh climate; the cavalier, a more generous display of nature; but each had to wrest wide areas from the wilderness before the landscape could become in any sense domestic. As this domestication of the land went on, the colonists found birds coming about their dwellings, building nests in their gardens and in the shelter of their barns, and they began taking note of many of the wild plants that grew in their neighborhood. By the time some of the earlier accounts were written, the settlers had already made the acquaintance of a number of the more familiar kinds and had given them names. It was the England of Elizabeth that was transplanted in New England and Virginia, and a considerable body

of old world folk-lore was a part of this transplanting much of which has come down to us in the names of plants and in the various other forms of speech. Garden-craft and the 'art of simpling' was a part of every housewife's knowledge, and plants were diligently sought for their healing virtues. Knowledge of this kind was also to some extent gained from the Indian inhabitants. In all the earlier descriptions of the new world such objects had a prominent place, together with the character of the land and aboriginal peoples and the advantages for settlement. One can see in these accounts the evident striving of the European mind to find suitable names and to describe an object by its likeness to familiar objects at home.

The few records that we have of the impressions of the earlier colonists are scattered through old journals, letters and histories of travel, and the references to plants and animals are often exceedingly obscure as to the species indicated. The question of the origin of names is at best recondite. Names are part of the folk-lore of peoples; they came into existence far back in a dim past, long before the period of written history. When we do find them gathered in ancient vocabularies, as in the one of Aelfric (955–1020 A.D.), we may be sure that they were even then venerable with age. The new world has added comparatively little to the stock of old world nomenclature. More often an old name has been given to an entirely different thing from the one that it originally stood for, and has been twisted into a new meaning with new associations. Thus the word *creek* originally meant the tidal estuary of a small river, a place where vessels might find harbor, and it is so used throughout Great Britain to-day. In certain parts of the United States, notably along the middle and southern Atlantic seaboard, the word has been extended to the small tributary of a river throughout its entire course. In England these little inland streams are called 'brooks,' which is clearly their rightful name—shallow water-courses with much tumbling and bickering over stony places. Milton very clearly distinguishes between the two where in 'Paradise Regained'

> Freshet or purling *brook*,

may be contrasted with the lines in 'Paradise Lost'

> Forthwith the sounds and seas, each *creek* and bay,

Both are here pictured with their characteristic associations, the one as an upland stream, the other as a tidal inlet. In the Bible the word 'creek' is used with perfect clearness as to its meaning in the description of Paul's shipwreck—"And when it was day, they knew not the land: but they discovered a certain *creek* with a shore, into which they were minded, if it were possible, to thrust in the ship." Here we have the idea of a harbor in the use of the word. It is possible, I think, to see how our brooks have come to be called 'creeks' when we reflect that south of New England the large rivers have many smaller streams

emptying into their tidal waters. The mouths of these are often deep enough to make a shelter for vessels, and they were undoubtedly so used by the early settlers. Hence the term 'creek' and its extension to the entire stream and to other similar streams far inland throughout a wide extent of country.

In portions of the middle Atlantic region the word 'cripple' was formerly used for dense, low-lying thickets, especially in wet ground. As a boy I occasionally heard it applied in this way, and it is quoted by Murray as occurring in the Penn-Logan Correspondence (1705). None of the dictionaries, however, attempt to trace it back to any dialectic source, nor is it given, with like meaning, in the vocabularies of provincial English. In the dialect of east England 'creeple' means to compress or squeeze, which might suggest the notion of a thicket. But words were not coined by the early settlers through mere suggestion; they had an ample supply for every-day use. This word 'cripple,' from its very local character, is undoubtedly a corruption of the Dutch word 'kreupelbosch,' signifying 'underwood,' the Anglicized form having been shortened by dropping the terminal 'bosch,' which means a wood or forest, and is allied to our now obsolete words, bosky and boscage. 'Kreupel' is an adjective meaning lame and suggests a creeping or halting mode of progression as in the common use of the English word. One who toils painfully through thickets with much inward, if not with outward, cursings will appreciate this most expressive word borrowed by our English settlers from their Dutch neighbors on the Hudson.

Swamp is more generally used in the United States than in England. It does not occur in the writings of either Shakespeare or Milton, though some of the minor poets make use of it and it is frequently found in the early descriptions of the colonies. The word implies wet, boggy ground in woods, with rank undergrowth, and is eminently characteristic of the wilder conditions of this country as compared with the more highly cultivated lands of Europe. The settlers, in this instance, had a keen sense of the fitness of the name. They early distinguished the treeless stretches of salt grass along the seacoast and river estuaries by the word *marsh*. *Fen* rarely if ever finds its way into American speech and writings, except when used in a poetical sense, as in Longfellow's 'fens of the Dismal Swamp.' *Swale* appears to have two meanings, a shady spot and a low rise of land. In provincial dialects it means both a vale and a shady place and in Northamptonshire 'a gentle rising in the ground.' In the western United States it refers to a boggy depression in a generally level stretch of country, and as a local word in New England it signifies an interval (intervale) or hollow, an umbrageous spot—the haunt of woodcock and other wild folk. *Valley* has replaced the older 'vale,' which now is found only in the poets' verse, and 'dale' has likewise suffered a

decadence save in the northern counties of England. Both vale and dale, however, survive as the terminations of many place-names in England and the United States. Valley seems to be equivalent to the lowland along a river's course, while vale and dale have to do with smaller streams, or more often with woodland hollows. In the following passage there is evidently this view in the writer's mind:

> The Land higher up the Rivers throughout the whole country, is generally a level Ground, with shallow Vallies, full of Streams and pleasant Springs of clear water, having interspers'd here and there among the large Levels, some small Hills, and extensive Vales. (Beverley's 'Virginia.')

In the south, and to some extent in the western states, the word 'branch' is widely used for brook. Beverley, in his account of Virginia, speaks of 'Gravelly Branches of Chrystal Streams.' *Freshet,* now synonymous with the overflow or flooding of a stream, was formerly used in the same sense as brook, as in the line of Milton above quoted. The term is said to be locally in use in Maryland to-day. Once when fishing along a small stream in southern Nova Scotia, a young lad who accompanied me remarked that it was 'most too low a freshet for good fishing.' This was a new meaning of the word to one who always had associated it with floods, but it was without doubt a survival, in a slightly altered form, of its original sense. The Anglo-Saxon *Fersc,* from which the modern English 'fresh' is derived, meant 'on the move,' and was originally applied to 'running' or 'fresh' water. *Run,* synonymous with brook, is a survival in America of 'rine,' 'rindel' and 'runnel,' of old English dialects.

The word 'rabbit' perpetuates a surprising want of observation on the part of those who first gave this name to the American species. The so-called 'rabbits' of this country are hares, not rabbits. Yet one would argue himself unknown who was pedantic enough to speak of hare-shooting before the 'great unwashed democracy of America.' The true rabbit is an old world species, makes burrows for its habitations, and brings forth helpless, naked young, as every boy knows who has kept tame rabbits. The wild 'cotton-tail' of this country, and all its kin, never burrow, but make a 'form' like the true hares of Europe, and the young are lively, well furred little creatures from the moment of birth.

America has lost some pleasing words which the English heart still holds dear through many delightful associations. *Copse* and *coppice* are thus lost to us on this side of the Atlantic. I feel sure that many who live their lives in literature would be glad to call some beloved patch of underwoods a 'coppice,' just for the sake of literary associations. One can do so to himself if he likes, but it is best to say 'thicket' to the world at large. And thicket is an old word and a good one too, even when shortened to 'thick,' as in provincial English. It savors of wilder places than coppice, which refers to underwoods that are annually cut for fuel and which put out fresh shoots each year,

while thicket has about it more of the delightful abandon of nature. We are not alone in this matter of lost words in the common speech. In England, as well as in America, the word *glade* has passed from every-day speech, and more 's the pity, for it is a charming word when associated with its real meaning of an open, sun-lit space in the woods, a place of gladness in the midst of gloom.

The varied features of the American wilderness—swamp and creek, hill, dale and river valley, and over all the forest of a primeval world with its wild life untouched by any hand save that of nature—these waited the coming of a people that would give them, by name and word, a place and part in another world, a world of literature. A large measure of man's curiosity concerning the things of his environment has been directed to finding out the nature and virtues of the divers kinds of plants that seemed to grow mainly for his use and delectation. This plant lore antedates the oldest written history. From the very beginning it has been a part of man's self in the food question and in the healing of bodily ills. The greater number of our wild herbs and trees, as well as the long domesticated varieties, received their names in a time so long past that only the names themselves can reveal their origin. Here is history that outdoes Homer and Herodotus and all the writings of the ancients. In the words of Prior, the author of British Plant Names, we are led, in thinking over these names, "to recall the times from which they date, to picture to ourselves the living figures of our ancestors, to hear them speaking their obsolete dialect, and almost to make the weeds that shadow their grave tell more than their tombstone of its sleeping inhabitants."

The early colonists found many plants in the new world of kinds with which they were more or less familiar. Hence we find a predominance of European names in our American flora. Aside from this, many old world species began shortly to make their appearance in America and soon became naturalized on American soil. It is a matter of some interest to run through a Gray's 'Manual' and note how many of the species are naturalized from Europe. The origins of a large number of our English plant names are involved in a curious attitude of the medieval mind toward the productions of nature. These were regarded as presenting by their forms, colors, or other properties, tokens of the Divine will for the benefit of sinful man. This remarkable idea was embodied in what was known as the doctrine of signatures, and is thus set forth by William Coles in a quaint old work entitled the 'Art of Simpling.'

> **Through Sin and Sathan have plunged Mankinde into an Ocean of Infirmities, yet the Mercy of God which is over all his workes, maketh Grasse to grow upon the Mountains, and Herbes for the use of Men, and hath not only stamped upon them a distinct forme, but also given them particular Signatures, whereby a Man may read, even in legible characters, the use of them.**

A name that is dear to us as a welcome of the spring—hepatica—

came through this curious belief in signatures. Its three-lobed leaves were supposed to bear some resemblance to the lobes of the liver; hence, according to the doctrine of signatures, the plant must possess virtues that would heal the manifold complaints of that organ. Whitlow grass, the *Draba verna* of the botanist, was thought to be good for the whitlow or felon. Bloodroot, because of its red juice, could cure the bloody flux. Dandelion, *dent de leon*, was so called, according to Prior, by one Meyster Wilhelmus, a surgeon, as set forth in the Ortus Sanitatis of 1486, from its wonderful virtue in the curing of disease, likening it to a lion's tooth. Saxifrage, comfrey, birthwort, eyebright, self-heal or heal-all, St. John's-wort, sanicle and a host of other more or less familiar wild flowers, each bore some token of its use in the healing of various diseases.[1]

There were many plants, however, that were named for other reasons than that of signature, plants that were not reckoned in the art of simpling. The daisy was the 'eye of day'—dæges-eage—of the old Anglo-Saxons, but the daisy that we know in America—the pest of the farmer and the delight of the wayfarer—is not the daisy of Chaucer and of Shakespeare. It is the great or ox-eye daisy, a plant of a different genus. Why the 'wee, modest, crimson-tipped flow'r' of Britain's fields never gained a foot-hold in this country, while the great, white ox-eye has become naturalized as our American daisy, is one of those questions which the student of distribution has to solve. If we can not have the poet's flower itself we must at least have the name; that is the privilege of our inheritance. It matters little if we give the name to another, even though it be a 'pernicious weed'; the name, aside from the intrinsic beauty of the flower, endows it with a charm that can never fade. Our eastern buttercups are mainly naturalized species. The one that is truly indigenous—the early crowfoot (*Ranunculus fascicularis*)—grows on rocky hillsides and in open woods, not in fields and meadows. There is little that touches the fancy in either 'butter' or 'cup,' but join the two in one word and you have a picture of green pastures sprinkled with gold. The name is an old one. It appears in early English speech, and some authorities would derive it from 'button-cop,' literally 'button-head,' allied to the French *bouton d'or*. 'Butter-cup,' however, has survived, possibly by virtue of its golden chalice, and the name must always be associated with childhood and with spring—with delectable places in the heyday of life. King's-cups and gold-cups are other old names, and cuckoo-buds was still another epithet given to these flowers, for we find it in old dialects and in poetry—

[1] This same religious significance is found in the term 'lady,' or 'ladies,' applied to many plants both in England and America as a corruption of 'Our Lady,' reference being to the Virgin Mary. From a more remote source, in the old pagan mythology, 'Venus' has survived in certain of our plant names—as in Venus slipper (*Cypripedium*), Venus comb, Venus looking-glass, etc.

And cuckoo-buds of yellow hue,
Do paint the meadows with delight,

Shakespeare, however, never once mentions 'buttercup' and we are left to infer the fact that it was buttercups that he had in mind, for it is given as such in old vocabularies. Cuckoo-bud is a charming name, and in England is suggestive of the time of year when the cuckoo begins to sing. But, alas, our American cuckoo is a dismal failure as a vocalist, though his morals are unimpeachable, and we have no good reason for calling flowers after him.[2]

A number of familiar plant names occur in the writings of the old herbalists, as in Gerarde's *Herbal* (1597), and in Parkinson's *Paradisi In Sole* (1629), which contains 'The Garden of Pleasant Flowers.' Here we find such names as crowfoot, toad-flax, snapdragon, columbine, dittany, golden-rod, dog's-tooth violet and many more that sound pleasantly of wayside places. A large class of names are adoptions, applied to plants more or less different from those that bore the original names in England. Thus 'wake robin,' given locally in Great Britain to a species of arum, has been transferred in America to the species of *Trillium*. 'Jack-in-the-box,' a local name of the English arum, appears in America as 'jack-in-the-pulpit,' bestowed upon a closely related plant. Name after name of familiar American herbs and trees may thus be traced back to the provincial speech of England.[3] It might even be possible to trace certain of the settlers back to the district in England from which they emigrated by the local names which they gave to certain plants in America. This at least offers an inviting field for the student of folk-lore.

Of the names that are purely American in origin we have a few well-known examples that have been derived from the Indian peoples. *Puccoon* seems to have been a general name for plants that furnished a juice used by the natives for dyeing and for decorating their bodies. Clayton in the 'Flora Virginica' (1739) thus designates the blood-root (*Sanguinaria*), and it is the common name of several species of gromwell (*Lithospermum*) which yield a yellowish juice, of the yellow-root (*Hydrastis*), and also of the poke-weed (*Phytolacca*) the berries of which stain a deep purple. The word 'poke' is probably a corrup-

[2] A great variety of English wild flowers have been called after the cuckoo, but few if any have survived in American speech. The cuckoo's name appears not only among plants, but in numerous other objects and customs as a survival of old English rural life. Thus, the term 'cuckoo-ale' which is found in provincial dialects, is 'ale drank to welcome the cuckoo's return.' "A singular custom," according to Wright, "prevailed not long ago in Shropshire, that as soon as the first cuckoo had been heard, all the laboring classes left work, and assembled to drink what is called the cuckoo ale." The sweet influence of the hedge-row was evidently close to the heart of these simple country folk.

[3] *Dogwood*, for example, is a name having no reference to the animal, but is derived from the old English *dagge*—a skewer, the wood having been used by butchers for this purpose. *Witch-hazel* has nothing whatever to do with witches, notwithstanding its reputed powers in divination, but is borrowed from the wych-elm, the wood of that tree having been used in making chests called 'wyches.' (Prior.)

tion of the original 'puccoon,' as suggested by Bartlett. 'Hickory' is the Anglicized ending of the Algonquin word *powcohicora* which meant a dish compounded of the kernel of the hickory nut, without reference to the tree itself. Persimmon, sassafras, papaw, catalpa, pipsissewa, pecan, chinquapin, cohosh, maracock (passion flower), kinnikinnik, and others are all more or less garbled forms of aboriginal names. Certain species became known by names suggested from their early association with certain uses or from various peculiarities and properties. Rattlesnake-root and rattlesnake-plantain were greatly esteemed by the native peoples as antidotes for the poison of the reptile. A number of different plants bear the name of 'snake-root,' all of them with supposed virtues in curing the bites of serpents. One of them, the Virginia snake-root (*Aristolochia Serpentaria*), figures in Gerarde's 'Herbal.' "There's the Snake-Root," says Beverley, "so much admired in England for a Cordial, and for being a great Antidote in all Pestilential Distempers." A 'swamp-root' was very early used by the settlers in Virginia for the fever and ague, and the virtues of some plant bearing this name are still exploited, at least in the advertisements of quack doctors. The old chroniclers of America were profound believers in 'simples,' and the early accounts of the country set forth, at considerable length, the medicinal value of various plants. Josselyn, in 'New England's Rarities Discovered,' is a mine of information in this respect. Uses, other than medicinal, have given rise to certain local names. The candle-berry tree—the sweet bay or myrtle of Carolina (*Myrica*)—was so called from the use of its wax-like berries in the making of candles by the settlers. "If an Accident puts a Candle out, it yields a pleasant Fragrancy to all that are in the Room; insomuch, that nice People often put them out, on purpose to have the Incense of the expiring Snuff."

Such names as squaw-root, papoose root, Seneca snake-root, bowman's root, Osage orange, arrowwood, Indian turnip, and the like, have a decided aboriginal flavor and probably hold a story quite as fascinating as any in the Anglo Saxon lineage. Dim pictures of the life of this vanished people will rise before the mind with many of these plant names. The beautiful native orchids of the genus *Cypripedium* that grow in remote woodland places, are called by their Indian name of 'moccasin flower' quite as often as by that which allies them to the old world history of plants and men. In Gray's Manual there is a short sentence that to me has a peculiar and indefinable charm, where wild tobacco is spoken of as occurring in 'old fields from New York westward and southward: a relic of cultivation by the Indians.' What a picture in this brief statement of wigwams in the ancient woods, or in sun-lit clearings, with Indian women hoeing among their maize, squashes, and tobacco!

The effort of the early colonists to give familiar titles to the objects

which they found in their new home is apparent in the vernacular names bestowed upon a number of our native birds. It was most natural that a bird so well known and so generally beloved as the English robin-redbreast should find a namesake in America, even though very different in habits and appearance. When the engaging birds with russet breasts came about the New England settlements in early spring, and cheerful pipings sounded through the clearings, 'robin' became a term of welcome and endearment. In some early notices of the bird the entire old world name of robin-redbreast was given. 'Daw' was an early name given to the crow blackbird or purple grackle by the settlers in the Middle Colonies and in Virginia. Though but distantly related to the jackdaw of England, this grackle[4] undoubtedly suggested the name from its habit of gathering in colonies about dwellings, where in the tops of tall pines and other shade trees it builds bulky nests. The jackdaw frequents belfrys and towers, but our blackbird has more of the rook in its nature, although a very different bird both in size and general appearance. The flocking of these grackles about the grounds of country houses and the noise of their vernal clatter is a welcome sign of returning spring. It savors of old homesteads in cultivated lands and suggests ancestral holdings, like the rooks in an English spinney or the daws in castle towers. In this vein of thought Lowell says 'they are the best substitute we have for rooks.' 'Blackbird' could only have been suggested by the generally dark color of the bird seen at a distance and in certain lights. There is nothing about our grackle that is in any way like the English blackbird.

A name is frequently the symbol of some striking characteristic as of color, or peculiarity of voice. Bluebird, redbird, yellow warbler, goldfinch and many others are full of color suggestion, while catbird, chat, phœbe, bobolink, towhee, song sparrow, and the like, appeal to the auditory sense. The bluebird, the nearest we have in this country to the English robin-redbreast and quite as lovable a bird in its way, has found a place in literature as it has in the hearts of all true lovers of the countryside. Alexander Wilson, poet and ornithologist, but first of all a poet, felt the charm of this bird when he immortalized its name in sympathetic prose and verse. The cardinal grosbeak was known as 'redbird' to the Virginia settlers, and, later, when much prized in London as a cage bird, its mellow, whistling notes won for it the title of 'Virginia nightingale.' 'Cardinal' has without doubt come into our language through the French of Louisiana, and possibly also, from the West Indies. The final 'grosbeak' is little used in general talk. I have lately heard some persons speak of this bird as the

[4] We are indebted to science for this word 'grackle' which is an Anglicized form of the Latin *Gracula*—a jack daw, a proof that even the scientific mind was biased in favor of recognizing the distant relationship. The black bird of England is a thrush—the ouzel cock or merle of the old English poets.

'Kentucky Cardinal,' an illustration of the influence of literature in idealizing a thing and making it a part of one's emotional assets.

We have nothing in America that quite takes the place of the English skylark and the nightingale. The mockingbird, the thrasher, the bobolink, the wood thrush, the hermit thrush, and the veery are so entirely different in their songs and their surroundings that comparison of any one of them with either of the foreign birds is impossible. Why our great stalking meadow lark ever became a 'lark,' and not a 'starling' as it should be called, is hard to see, unless its liquid spring notes and its nesting in fields appealed to the early settlers in lieu of any other bird better fitted to bear this glorious name. It seems to be a clear case of name transfer for the sake of the name itself. The catbird is damned by such a title. His summer mewings have played an ugly trick on him, for he is a songster of no mean ability. William Bartram quaintly speaks of his endeavors at imitation, 'even in rehearsing the songs, which he attentively listens to, from the shepherdess and rural swain'—words that call up an Arcadian scene that even Theocritus might have loved; a haunt of Pan in days before the smoke and noise of modern industry sullied the sweet air of fields and groves.

The reader may ask—Why all this pother about names? A name is a name, and, though its history be of passing interest, what need further to talk about it? If literature is the reflection of a people's life the words which give it form and substance are a part of the life itself, at least of its emotional and intellectual reactions. Our appreciation of nature comes so largely through literature, and literature has so greatly extended our sympathy toward things natural, both animate and inanimate, that in this world of words we may be said almost to live and move and have our being. This is the plea that is made for the interest in a name; for the better understanding of the really vital part that it plays in human life.

The past fifty years have seen the growth in America of a remarkable interest in nature, not only in its scientific aspects, but in its esthetic appeal as well. The modern cult of 'nature study' is an expression of this interest and as such is altogether salutary. How much this attitude toward nature is fostered by literature is apparent in the mass of matter that has been and is being written upon the subject. Where one person has reached this state of mind through a sort of primitive instinct that takes him out into direct contact with nature, fifty persons have been led into the same happy state through some appreciative writer like Gilbert White, Richard Jefferies, Thoreau or Burroughs. A truly good book, one that makes its appeal to the heart, calls us into the open where the whole man is refreshed by nature at first hand. In order to read understandingly and sympathetically, one must know the real thing itself, must have had his senses quickened by the thousand influences of wood and field. Then a name will have

a meaning to the reader that it never before possessed, and its history will have a meaning when he finds it in the writings of the old world authors. Those of us who are in the middle years of life can remember when our juvenile nature literature was almost entirely English and we became more intimately acquainted with the robin-redbreast and the nightingale, the skylark and the thrush, than we did with our own native birds, whose names were often quite unknown to us. The writings of the English poets and authors from Chaucer down are full of allusions to birds and flowers with which most of us have grown familiar by name only. Shelley's 'Skylark' and Keats' 'Ode to a Nightingale' have made the names living realities to many who have never seen or heard these birds. There are sweet singers in our own country that must take a place in literature, and their names will be doubly dear to the heart through an intimate acquaintance with the birds themselves. One of the most sympathetic of our modern writers has voiced this thought in an exquisite bit of verse—'The Wood-notes of the Veery.'

If two different birds, or two different flowers, in England and America bear the same name, there is no need to cavil, only to recognize the fact that there is a difference. This extension of the name is in itself a source of great interest; it helps to link us to the life and literature of past generations, and in so doing to develop an intelligent and sympathetic understanding. One might have in mind our crow blackbird when reading Tennyson's poem—'The Blackbird,' and fail to see its truth and beauty, simply by not knowing that there are several birds of this name.

> **A golden bill! the silver tongue,**
> **Cold February loved, is dry:**
> **Plenty corrupts the melody**
> **That made thee famous once, when young:**

No one who knew our blackbird could ever apply this description to him. It more aptly applies to the robin than to any other bird in this country. The golden bill; the silver tongue of our early spring; the corruption of melody when gorged with autumnal fruit; all these are thrush attributes and apply with equal pertinence to both species.

An appreciation of the rightful meaning of a name will go far toward making a true mind picture of the thing itself. A poet like Tennyson was a keen observer of nature, to the slightest detail, and a reader gains the greater pleasure when he divines this quality in the poet's verse. This is not a scientific attitude of mind, not the attitude of a carping critic, but the realization of a certain beauty because of a certain truth—and truth is after all the one thing needful, the only thing that satisfies the soul.

COMPARATIVE PSYCHOLOGY

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COMPARATIVE psychology has arrived. We have had our Descartes and our psychic epiphenomenalists; and their descendants, the vital mechanicians, are still with us. And no Luther has arisen to shatter at a stroke their gods (of tin and other artificers' materials) and proclaim the reformation of psychology in a single revolutionary *coup*. No Darwin has struck off a hypothesis of psychogenesis full grown and puissant to drive its decadent rivals from the field by virtue of its own all-assimilating vitality. But the leaven of Darwinism has been slowly permeating, even into the dusty meal bins of speculative psychology. In spite of fervid anathemas from the citadels of the categorical intuitionalists, the steady growth of genetic ideas has by natural process begun to corrode the very foundations of these strongholds of conservatism; for have we not already begun our natural history of the intuitions and their genesis?

It has been pointed out as a most hopeful sign that this new psychology (unlike that sometimes falsely so called) does not come bearing as its ikons a glittering array of brass instruments of precision and tomes of statistics; but, like the kingdom of Heaven, it cometh not with observation, as a change of mental attitude among both psychologists and naturalists.

There is apparently no general recognition of the revolutionary character of this feature, which is implicit in many movements now current in science and philosophy—movements bearing as diverse labels in the philosophical vernacular of the day as 'experimental evolution,' 'genetic psychology' (in a score of mutually antagonistic forms), 'pragmatism,' 'functional philosophy,' 'paidology,' 'dynamic monism,' etc., etc. So far as the genetic element in these systems is true, it is destined to outlive its ephemeral and sometimes bizarre setting, and the day when we shall have a generally accepted doctrine of psychogenesis and psychic evolution is certainly not far off, though it would be folly to assert that this day has yet dawned.

One of the most valuable features of the remarkable book by Stanley Hall on the psychology of adolescence is the emphasis which he places on the study of the past of mind as a corrective to the morbid speculations on its future which comprise the larger part of

the current doctrines of the soul. The ages of psychic evolution through which we have passed have not only cast their shadows down the ranks of time to our own day, but their life is now coursing in our mental pulses as literally as in our corporeal. He goes on to say:

> **The best and only key to truly explain mind in man is in the animals he has sprung from and in his own infancy which so faintly recapitulates them; for about every property of the human mind is found in animal mind, as those of higher animals are found in the powers of the lower. . . . The conscious adult person is not a monad reflecting the universe, but a fragment broken off and detached from the great world of soul, always maimed, defined by special limitations, like, yet different from, all others, with some incommensurability parting it off as something unique, well fitted to illustrate some aspects and hopelessly unable to exemplify or even know other regions in the cosmos of soul.**

But the trouble is that as soon as a professional philosopher approaches the problems of the cosmic past of mind he is clapped automatically into some metaphysical pigeon hole, whose rigid and often misshapen walls determine that every effort which he puts forth must be molded by past tradition. The very assimilation of the newer data of science, which are the philosopher's meat and drink, involves their incorporation into a metaphysical system already thoroughly organized, and so we read our metaphysics backward through the cosmic process.

The naturalists, accordingly, are calling for a new *Naturphilosophie* which shall be 'anti-metaphysical,' and yet every new such attempt on their own part seems to present more serious metaphysical vices than the preceding. It is obvious that the hope for an anti-metaphysical philosophy is vain, for human philosophic systems flow into metaphysics as the sparks fly upward.

But what shall be the foundation of that metaphysic and the manner of its building is the naturalist's own problem. Shall it be an *a priori* system based upon ancient and mediæval dialectic or shall it be an organic growth whose roots sink deep into the soil of scientific observation and induction? This is a very burning question; for while we can have a practically efficient hod-man type of science without metaphysics, there can be no hope of a future for any metaphysics which is not built up and sustained by the progress of science.

This, of course, can only mean that our metaphysics can not be bound down by the rigid categories of formal logic (which is but a crystallization of the past workings of the human mind); it too must be alive with the lusty vigor of active growth. That such a metaphysic is not unattainable is evident. Certain present tendencies are nothing less than revolutionary in the direction of a really vital metaphysic, and not a few men of science are making their contributions to the same end.

And herein lies the great hope and promise of an immediate fruit-

fulness in the field of comparative psychology. For the first time in the history of thought, we have both a scientific and a philosophic public sentiment ripe for a serious attempt at a correlation in scientific channels of mental and physical evolution and of mind and body in the broader view.

But how imperfectly are we able to enter into the inner life of even the higher animals whose minds are most like our own! And yet, who knows how many of the powerful, though subconscious springs of our own impulse and motive may lie concealed in inherited vestiges of long-vanished and far more remote ancestral mental powers? Who knows what may be the mental life of a catfish, whose barbels and whole outer body surface are covered with organs of taste and whose gustatory nerves and centers are the biggest in the brain, or of a shark which has an elaborate system of sense organs (the lateral line canals), totally unknown to our own experience, which reach the extreme dimensions of the body and serve as a sort of intermediary apparatus between the organs of touch and the labyrinth of the ear, which is likewise highly developed, though the fish is apparently nearly or quite deaf?

The first task of comparative psychology, then, is to define as accurately as we may with the imperfect means at command the sensorimotor life of the whole range of lower organisms. And this task is fortunately not only approachable, but intrinsically attractive to every lover of nature. The study in field and laboratory of the sensory life of animals, while not all of comparative psychology, is a necessary introduction to its larger correlations and is receiving a rapidly increasing attention by naturalists of all schools; for the development of a true comparative psychology is, as we have seen, bound up with some of the greatest of the current movements in both science and philosophy.

THE VALUE OF SCIENCE

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§ 3. *Tactile Space*

THUS I know how to recognize the identity of two points, the point occupied by A at the instant α and the point occupied by B at the instant β, but only *on one condition*, namely, that I have not budged between the instants α and β. That does not suffice for our object. Suppose, therefore, that I have moved in any manner in the interval between these two instants, how shall I know whether the point occupied by A at the instant α is identical with the point occupied by B at the instant β? I suppose that at the instant α, the object A was in contact with my first finger and that in the same way, at the instant β, the object B touches this first finger; but at the same time, my muscular sense has told me that in the interval my body has moved. I have considered above two series of muscular sensations S and S', and I have said it sometimes happens that we are led to consider two such series S and S' as inverse one of the other, because we have often observed that when these two series succeed one another our primitive impressions are reestablished.

If then my muscular sense tells me that I have moved between the two instants α and β, but so as to feel successively the two series of muscular sensations S and S' that I consider inverses, I shall still conclude, just as if I had not budged, that the points occupied by A at the instant α and by B at the instant β are identical, if I ascertain that my first finger touches A at the instant α and B at the instant β.

This solution is not yet completely satisfactory, as one will see. Let us see, in fact, how many dimensions it would make us attribute to space. I wish to compare the two points occupied by A and B at the instants α and β, or (what amounts to the same thing since I suppose that my finger touches A at the instant α and B at the instant β) I wish to compare the two points occupied by my finger at the two instants α and β. The sole means I use for this comparison is the series Σ of muscular sensations which have accompanied the movements of my body between these two instants. The different imaginable series Σ form evidently a physical continuum of which the number of dimensions is very great. Let us agree, as I have done, not to consider as distinct the two series Σ and $\Sigma + s + s'$, when s and s' are inverses one of the other in the sense above given to this word; in spite of this

agreement, the aggregate of distinct series Σ will still form a physical continuum and the number of dimensions will be less but still very great.

To each of these series Σ corresponds a point of space; to two series Σ and Σ' thus correspond two points M and M'. The means we have hitherto used enable us to recognize that M and M' are not distinct in two cases: (1) if Σ is identical with Σ'; (2) if $\Sigma' = \Sigma + s + s'$, s and s' being inverses one of the other. If in all the other cases we should regard M and M' as distinct, the manifold of points would have as many dimensions as the aggregate of distinct series Σ, that is, much more than three.

For those who already know geometry, the following explanation would be easily comprehensible. Among the imaginable series of muscular sensations, there are those which correspond to series of movements where the finger does not budge. I say that if one does not consider as distinct the series Σ and $\Sigma + \sigma$, where the series σ corresponds to movements where the finger does not budge, the aggregate of series will constitute a continuum of three dimensions, but that if one regards as distinct two series Σ and Σ' unless $\Sigma' = \Sigma + s + s'$, s and s' being inverses, the aggregate of series will constitute a continuum of more than three dimensions.

In fact, let there be in space a surface A, on this surface a line B, on this line a point M. Let C_0 be the aggregate of all series Σ. Let C_1 be the aggregate of all the series Σ, such that at the end of corresponding movements the finger is found upon the surface A, and C_2 or C_3 the aggregate of series Σ such that at the end the finger is found on B, or at M. It is clear, first that C_1 will constitute a cut which will divide C_0, that C_2 will be a cut which will divide C_1, and C_3 a cut which will divide C_2. Thence it results, in accordance with our definitions, that if C_3 is a continuum of n dimensions, C_0 will be a physical continuum of $n + 3$ dimensions.

Therefore, let Σ and $\Sigma' + \sigma$ be two series forming part of C_3; for both, at the end of the movements, the finger is found at M; thence results that at the beginning and at the end of the series σ, the finger is at the same point M. This series σ is therefore one of those which correspond to movements where the finger does not budge. If Σ and $\Sigma + \sigma$ are not regarded as distinct, all the series of C_3 blend into one; therefore C_3 will have 0 dimension, and C_0 will have 3, as I wished to prove. If, on the contrary, I do not regard Σ and $\Sigma + \sigma$ as blending (unless $\sigma = s + s'$, s and s' being inverses), it is clear that C_3 will contain a great number of series of distinct sensations; because, without the finger budging, the body may take a multitude of different attitudes. Then C_3 will form a continuum and C_0 will have more than three dimensions, and this also I wished to prove.

We who do not yet know geometry can not reason in this way; we can only verify. But then a question arises; how, before knowing geometry, have we been led to distinguish from the others these series σ where the finger does not budge? It is, in fact, only after having made this distinction that we could be led to regard Σ and $\Sigma + \sigma$ as identical, and it is on this condition alone, as we have just seen, that we can arrive at space of three dimensions.

We are led to distinguish the series σ, because it often happens that when we have executed the movements which correspond to these series σ of muscular sensations, the tactile sensations which are transmitted to us by the nerve of the finger that we have called the first finger, persist and are not altered by these movements. Experience alone tells us that and it alone could tell us.

If we have distinguished the series of muscular sensations $s + s'$ formed by the union of two inverse series, it is because they preserve the totality of our impressions; if now we distinguish the series σ, it is because they preserve *certain* of our impressions. (When I say that a series of muscular sensations s 'preserves' one of our impressions A, I mean that we ascertain that if we feel the impression A, then the muscular sensations s, we *still* feel the impression A *after* these sensations s.)

I have said above it often happens that the series σ do not alter the tactile impressions felt by our first finger; I said *often*, I did not say *always*. This it is that we express in our ordinary language by saying that the tactile impressions would not be altered if the finger has not moved, *on the condition* that *neither has* the object A, which was in contact with this finger, moved. Before knowing geometry, we could not give this explanation; all we could do is to ascertain that the impression often persists, but not always.

But that the impression often continues is enough to make the series σ appear remarkable to us, to lead us to put in the same class the series Σ and $\Sigma + \sigma$, and hence not regard them as distinct. Under these conditions we have seen that they will engender a physical continuum of three dimensions.

Behold then a space of three dimensions engendered by my first finger. Each of my fingers will create one like it. It remains to consider how we are led to regard them as identical with visual space, as identical with geometric space.

But one reflection before going further; according to the foregoing, we know the points of space, or more generally the final situation of our body, only by the series of muscular sensations revealing to us the movements which have carried us from a certain initial situation to this final situation. But it is clear that this final situation will depend, on the one hand, upon these movements and, *on the other hand, upon the initial situation* from which we set out. Now these movements are re-

vealed to us by our muscular sensations; but nothing tells us the initial situation; nothing can distinguish it for us from all the other possible situations. This puts well in evidence the essential relativity of space.

§ 4. *Identity of the Different Spaces*

We are therefore led to compare the two continua C and C' engendered, for instance, one by my first finger D, the other by my second finger D'. These two physical continua both have three dimensions. To each element of the continuum C, or, if you prefer, to each point of the first tactile space, corresponds a series of muscular sensations Σ, which carry me from a certain initial situation to a certain final situation.[1] Moreover, the same point of this first space will correspond to Σ and to $\Sigma + \sigma$, if σ is a series of which we know that it does not make the finger D move.

Similarly to each element of the continuum C', or to each point of the second tactile space, corresponds a series of sensations Σ', and the same point will correspond to Σ' and to $\Sigma' + \sigma'$, if σ' is a series which does not make the finger D' move.

What makes us distinguish the various series designated σ from those called σ' is that the first do not alter the tactile impressions felt by the finger D and the second preserve those the finger D' feels.

Now see what we ascertain: in the beginning my finger D' feels a sensation A'; I make movements which produce muscular sensations S; my finger D feels the impression A; I make movements which produce a series of sensations σ; my finger D continues to feel the impression A, since this is the characteristic property of the series σ; I then make movements which produce the series S' of muscular sensations, *inverse* to S in the sense above given to this word. I ascertain then that my finger D' feels anew the impression A'. (It is of course understood that S has been suitably chosen.)

This means that the series $s + \sigma + s'$, preserving the tactile impressions of the finger D', is one of the series I have called σ'. Inversely, if one takes any series σ', $s' + \sigma' + s$ will be one of the series that we call σ.

Thus if s is suitably chosen, $s + \sigma + s'$ will be a series σ', and by making σ vary in all possible ways, we shall obtain all the possible series σ'.

Not yet knowing geometry, we limit ourselves to verifying all that, but here is how those who know geometry would explain the fact. In the beginning my finger D' is at the point M, in contact with the object a, which makes it feel the impression A'. I make the movements corresponding to the series S; I have said that this series should be suitably

[1] In place of saying that we refer space to axes rigidly bound to our body, perhaps it would be better to say, in conformity to what precedes, that we refer it to axes rigidly bound to the initial situation of our body.

chosen, I should so make this choice that these movements carry the finger D to the point originally occupied by the finger D', that is, to the point M; this finger D will thus be in contact with the object a, which will make it feel the impression A.

I then make the movements corresponding to the series σ; in these movements, by hypothesis, the position of the finger D does not change, this finger therefore remains in contact with the object a and continues to feel the impression A. Finally I make the movements corresponding to the series S'. As S' is inverse to S, these movements carry the finger D' to the point previously occupied by the finger D, that is, to the point M. If, as may be supposed, the object a has not budged, this finger D' will be in contact with this object and will feel anew the impression A'. . . . *Q. E. D.*

Let us see the consequences. I consider a series of muscular sensations Σ. To this series will correspond a point M of the first tactile space. Now take again the two series s and s', inverses of one another, of which we have just spoken. To the series $s + \Sigma + s'$ will correspond a point N of the second tactile space, since to any series of muscular sensations corresponds, as we have said, a point, whether in the first space or in the second.

I am going to consider the two points N and M, thus defined, as corresponding. What authorizes me so to do? For this correspondence to be admissible, it is necessary that if two points M and M', corresponding in the first space to two series Σ and Σ', are identical, so also are the two corresponding points of the second space N and N', that is the two points which correspond to the two series $s + \Sigma + s'$ and $s + \Sigma' + s'$. Now we shall see that this condition is fulfilled.

First a remark. As S and S' are inverses of one another, we shall have $S + S' = 0$, and consequently $S + S' + \Sigma = \Sigma + S + S' = \Sigma$, or again $\Sigma + S + S' + \Sigma' = \Sigma + \Sigma'$; but it does not follow that we have $S + \Sigma + S' = \Sigma$; because, though we have used the addition sign to represent the succession of our sensations, it is clear that the order of this succession is not indifferent: we can not, therefore, as in ordinary addition, invert the order of the terms; to use abridged language, our operations are associative, but not commutative.

That fixed, in order that Σ and Σ' should correspond to the same point $M = M'$ of the first space, it is necessary and sufficient for us to have $\Sigma' = \Sigma + \sigma$. We shall then have: $S + \Sigma' + S' = S + \Sigma + \sigma + S' = S + \Sigma + S' + S + \sigma + S'$.

But we have just ascertained that $S + \sigma + S'$ was one of the series σ'. We shall therefore have: $S + \Sigma' + S' = S + \Sigma + S' + \sigma'$, which means that the series $S + \Sigma' + S'$ and $S + \Sigma + S'$ correspond to the same point $N = N'$ of the second space. *Q. E. D.*

Our two spaces therefore correspond point for point; they can be

'transformed' one into the other; they are isomorphic. How are we led to conclude thence that they are identical?

Consider the two series σ and $S + \sigma + S' = \sigma'$. I have said that often, but not always, the series σ preserves the tactile impression A felt by the finger D; and similarly it often happens, but not always, that the series σ' preserves the tactile impression A' felt by the finger D'. Now I ascertain that it happens *very often* (that is, much more often than what I have just called 'often') that when the series σ has preserved the impression A of the finger D, the series σ' preserves at the same time the impression A' of the finger D'; and, inversely, that if the first impression is altered, the second is likewise. That happens *very often*, but not always.

We interpret this experimental fact by saying that the unknown object a which gives the impression A to the finger D is identical with the unknown object a' which gives the impression A' to the finger D'. And in fact when the first object moves, which the disappearance of the impression A tells us, the second likewise moves, since the impression A' disappears likewise. When the first object remains motionless, the second remains motionless. If these two objects are identical, as the first is at the point M of the first space and the second at the point N of the second space, these two points are identical. This is how we are led to regard these two spaces as identical; or better this is what we mean when we say that they are identical.

What we have just said of the identity of the two tactile spaces makes unnecessary our discussing the question of the identity of tactile space and visual space, which could be treated in the same way.

§ 5. *Space and Empiricism*

It seems that I am about to be led to conclusions in conformity with empiristic ideas. I have, in fact, sought to put in evidence the rôle of experience and to analyze the experimental facts which intervene in the genesis of space of three dimensions. But whatever may be the importance of these facts, there is one thing we must not forget and to which besides I have more than once called attention. These experimental facts are often verified but not always. That evidently does not mean that space has often three dimensions, but not always.

I know well that it is easy to save oneself and that, if the facts do not verify, it will be easily explained by saying that the exterior objects have moved. If experience succeeds, we say that it teaches us about space; if it does not succeed, we hie to exterior objects which we accuse of having moved; in other words, if it does not succeed, it is given a fillip.

These fillips are legitimate; I do not refuse to admit them; but they suffice to tell us that the properties of space are not experimental truths, properly so called. If we had wished to verify other laws, we

could have succeeded also, by giving other analogous fillips. Should we not always have been able to justify these fillips by the same reasons? One could at most have said to us: 'Your fillips are doubtless legitimate, but you abuse them; why move the exterior objects so often?'

To sum up, experience does not prove to us that space has three dimensions; it only proves to us that it is convenient to attribute three to it, because thus the number of fillips is reduced to a minimum.

I will add that experience brings us into contact only with representative space, which is a physical continuum, never with geometric space, which is a mathematical continuum. At the very most it would appear to tell us that it is convenient to give to geometric space three dimensions, so that it may have as many as representative space.

The empiric question may be put under another form. Is it impossible to conceive physical phenomena, the mechanical phenomena for example, otherwise than in space of three dimensions? We should thus have an objective experimental proof, so to speak, independent of our physiology, of our modes of representation.

But it is not so; I shall not here discuss the question completely, I shall confine myself to recalling the striking example given us by the mechanics of Hertz. You know that the great physicist did not believe in the existence of forces, properly so called; he supposed that visible material points are subjected to certain invisible bonds which join them to other invisible points and that it is the effect of these invisible bonds that we attribute to forces.

But that is only a part of his ideas. Suppose a system formed of n material points, visible or not; that will give in all $3n$ coordinates; let us regard them as the coordinates of a *single* point in space of $3n$ dimensions. This single point would be constrained to remain upon a surface (of any number of dimensions $< 3n$) in virtue of the bonds of which we have just spoken; to go on this surface from one point to another, it would always take the shortest way; this would be the single principle which would sum up all mechanics.

Whatever should be thought of this hypothesis, whether we be allured by its simplicity, or repelled by its artificial character, the simple fact that Hertz was able to conceive it, and to regard it as more convenient than our habitual hypotheses, suffices to prove that our ordinary ideas, and, in particular, the three dimensions of space, are in no wise imposed upon mechanics with an invincible force.

§ 6. *Mind and Space*

Experience, therefore, has played only a single rôle, it has served as occasion. But this rôle was none the less very important; and I have thought it necessary to give it prominence. This rôle would have been useless if there existed an *a priori* form imposing itself upon our sensitivity, and which was space of three dimensions.

Does this form exist, or, if you choose, can we represent to ourselves space of more than three dimensions? And first what does this question mean? In the true sense of the word, it is clear that we can not represent to ourselves space of four, nor space of three, dimensions; we can not first represent them to ourselves empty, and no more can we represent to ourselves an object either in space of four, or in space of three, dimensions: (1) Because these spaces are both infinite and we can not represent to ourselves a figure *in* space, that is, the part *in* the whole, without representing the whole, and that is impossible, because it is infinite; (2) because these spaces are both mathematical continua and we can represent to ourselves only the physical continuum; (3) because these spaces are both homogeneous, and the frames in which we enclose our sensations, being limited, can not be homogeneous.

Thus the question put can only be understood in another manner; is it possible to imagine that, the results of the experiences related above having been different, we might have been led to attribute to space more than three dimensions; to imagine, for instance, that the sensation of accommodation might not be constantly in accord with the sensation of convergence of the eyes; or indeed that the experiences of which we have spoken in paragraph 2 and of which we express the result by saying 'that touch does not operate at a distance,' might have led us to an inverse conclusion.

And *then evidently yes* that is possible. From the moment one imagines an experience, one imagines just by that the two contrary results it may give. That is possible, but that is difficult, because we have to overcome a multitude of associations of ideas, which are the fruit of a long personal experience and of the still longer experience of the race. Is it these associations (or at least those of them that we have inherited from our ancestors), which constitute this *a priori* form of which it is said that we have pure intuition? Then I do not see why one should declare it refractory to analysis and should deny me the right of investigating its origin.

When it is said that our sensations are 'extended' only one thing can be meant, that is that they are always associated with the idea of certain muscular sensations, corresponding to the movements which enable us to reach the object which causes them, which enable us, in other words, to defend ourselves against it. And it is just because this association is useful for the defense of the organism, that it is so old in the history of the species and that it seems to us indestructible. Nevertheless, it is only an association and we can conceive that it may be broken; so that we may not say that sensation can not enter consciousness without entering in space, but that in fact it does not enter consciousness without entering in space, which means, without being entangled in this association.

No more can I understand one's saying that the idea of time is log-

ically subsequent to space, since we can represent it to ourselves only under the form of a straight line; as well say that time is logically subsequent to the cultivation of the prairies, since it is usually represented armed with a scythe. That one can not represent to himself simultaneously the different parts of time, goes without saying, since the essential character of these parts is precisely not to be simultaneous. That does not mean that we have not the intuition of time. So far as that goes, no more should we have that of space, because neither can we represent it, in the proper sense of the word, for the reasons I have mentioned. What we represent to ourselves under the name of straight is a crude image which as ill resembles the geometric straight as it does time itself.

Why has it been said that every attempt to give a fourth dimension to space always carries this one back to one of the other three? It is easy to understand. Consider our muscular sensations and the 'series' they may form. In consequence of numerous experiences, the ideas of these series are associated together in a very complex woof, our series are *classed*. Allow me, for convenience of language, to express my thought in a way altogether crude and even inexact by saying that our series of muscular sensations are classed in three classes corresponding to the three dimensions of space. Of course this classification is much more complicated than that, but that will suffice to make my reasoning understood. If I wish to imagine a fourth dimension, I shall suppose another series of muscular sensations, making part of a fourth class. But as *all* my muscular sensations have already been classed in one of the three preexistent classes, I can only represent to myself a series belonging to one of these three classes, so that my fourth dimension is carried back to one of the other three.

What does that prove? This: that it would have been necessary first to destroy the old classification and replace it by a new one in which the series of muscular sensations should have been distributed into four classes. The difficulty would have disappeared.

It is presented sometimes under a more striking form. Suppose I am enclosed in a chamber between the six impassable boundaries formed by the four walls, the floor and the ceiling; it will be impossible for me to get out and to imagine my getting out. Pardon, can you not imagine that the door opens, or that two of these walls separate? But of course, you answer, one must suppose that these walls remain immovable. Yes, but it is evident that I have the right to move; and then the walls that we suppose absolutely at rest will be in motion with regard to me. Yes, but such a relative motion can not be anything; when objects are at rest, their relative motion with regard to any axes is that of a rigid solid; now, the apparent motions that you imagine are not in conformity with the laws of motion of a rigid solid.

Yes, but it is experience which has taught us the laws of motion of a rigid solid; nothing would prevent our *imagining* them different. To sum up, for me to imagine that I get out of my prison, I have only to imagine that the walls seem to open, when I move.

I believe, therefore, that if by space is understood a mathematical continuum of three dimensions, were it otherwise amorphous, it is the mind which constructs it, but it does not construct it out of nothing; it needs materials and models. These materials, like these models, preexist within it. But there is not a single model which is imposed upon it; it has *choice;* it may choose, for instance, between space of four and space of three dimensions. What then is the rôle of experience? It gives the indications following which the choice is made.

Another thing: whence does space get its quantitative character? It comes from the rôle which the series of muscular sensations play in its genesis. These are series which may *repeat themselves,* and it is from their repetition that number comes; it is because they can repeat themselves indefinitely that space is infinite. And finally we have seen, at the end of section 3, that it is also because of this that space is relative. So it is repetition which has given to space its essential characteristics; now, repetition supposes time; this is enough to tell that time is logically anterior to space.

§ 7. *Rôle of the Semicircular Canals*

I have not hitherto spoken of the rôle of certain organs to which the physiologists attribute with reason a capital importance, I mean the semicircular canals. Numerous experiments have sufficiently shown that these canals are necessary to our sense of orientation; but the physiologists are not entirely in accord; two opposing theories have been proposed, that of Mach-Delage and that of M. de Cyon.

M. de Cyon is a physiologist who has made his name illustrious by important discoveries on the innervation of the heart; I can not, however agree with his ideas on the question before us. Not being a physiologist, I hesitate to criticize the experiments he has directed against the adverse theory of Mach-Delage; it seems to me, however, that they are not convincing, because in many of them the *total* pressure was made to vary in one of the canals, while, physiologically, what varies is the *difference* between the pressures on the two extremities of the canal; in others the organs were subjected to profound lesions, which must alter their functions.

Besides, this is not important; the experiments, if they were irreproachable, might be convincing against the old theory. They would not be convincing *for* the new theory. In fact, if I have rightly understood the theory, my explaining it will be enough for one to understand that it is impossible to conceive of an experiment confirming it.

The three pairs of canals would have as sole function to tell us that space has three dimensions. Japanese mice have only two pairs of canals; they believe, it would seem, that space has only two dimensions, and they manifest this opinion in the strongest way; they put themselves in a circle, and, so ordered, they spin rapidly around. The lampreys, having only one pair of canals, believe that space has only one dimension, but their manifestations are less turbulent.

It is evident that such a theory is inadmissible. The sense-organs are designed to tell us of *changes* which happen in the exterior world. We could not understand why the Creator should have given us organs destined to cry without cease: Remember that space has three dimensions, since the number of these three dimensions is not subject to change.

We must, therefore, come back to the thory of Mach-Delage. What the nerves of the canals can tell us is the difference of pressure on the two extremities of the same canal, and thereby: (1) the direction of the vertical with regard to three axes rigidly bound to the head; (2) the three components of the acceleration of translation of the center of gravity of the head; (3) the centrifugal forces developed by the rotation of the head; (4) the acceleration of the motion of rotation of the head.

It follows from the experiments of M. Delage that it is this last indication which is much the most important; doubtless because the nerves are less sensible to the difference of pressure itself than to the brusque variations of this difference. The first three indications may thus be neglected.

Knowing the acceleration of the motion of rotation of the head at each instant, we deduce from it, by an unconscious integration, the final orientation of the head, referred to a certain initial orientation taken as origin. The circular canals contribute, therefore, to inform us of the movements that we have executed, and that on the same ground as the muscular sensations. When, therefore, above we speak of the series S or of the series Σ, we should say, not that these were series of muscular sensations alone, but that they were series at the same time of muscular sensations due to the semicircular canals. Apart from this addition, we should have nothing to change in what precedes.

In the series S and Σ, these sensations of the semicircular canals evidently hold a very important place. Yet alone they would not suffice, because they can tell us only of the movements of the head; they tell us nothing of the relative movements of the body, or of the members in regard to the head. And more, it seems that they tell us only of the rotations of the head and not of the translations it may undergo.

NOBEL MEDALS

The gold medals conferred in connection with the Nobel prizes are here shown. Above is the medal in physics and in chemistry. The obverse of the medals in medicine and in literature is the same; the reverse of each of these medals is shown beneath. At the bottom is the medal for the promotion of peace.

THE PROGRESS OF SCIENCE

THE NOBEL PRIZES

THE great prizes established by the will of Alfred Nobel were awarded for the sixth time on December 10, the anniversary of the death of the founder, as follows: Physics, Professor J. J. Thomson of Cambridge; chemistry, M. Moissan of Paris; medicine, Professor S. Ramón y Cajal of Madrid and Professor Camillo Golgi of Pavia; literature, Professor Giosuè Carducci of Bologna; for the promotion of peace among nations, President Roosevelt. These international awards, of the value of about $40,000, are of sufficient magnitude not only to be of interest to scientific men, but also to attract the attention of the civilized world. They are thus a real factor in increasing the dignity of the scientific career and in encouraging scientific work.

Regret has already been expressed here that the confidence placed by Nobel in his native land has not been justified. His large fortune was made in Great Britain by the discovery and manufacture of dynamite, and it seems likely that the instructions of his will would have been more adequately carried out if their execution had been entrusted to the Royal Society and the British courts. Nobel doubtless believed that the international obligations would be fully met by the Scandinavian countries, and it is truly sad and discouraging that there should be lack of good faith in the administration of a fund intended as the testator states 'to benefit mankind.'

Nobel's will is perfectly clear and explicit. It directs that the interest from the fund 'shall be divided into five equal parts,' which shall be annually awarded in prizes to those persons who shall have contributed most materially to benefit mankind during the year immediately preceding. "One share to the person who shall have made the most important discovery or invention in the domain of physics; one share to the person who shall have made the most important chemical discovery or improvement; one share to the person who shall have made the most important discovery in the domain of physiology or medicine; one share to the person who shall have produced in the field of literature the most distinguished work of an idealistic tendency, and, finally, one share to the person who shall have most or best promoted the fraternity of nations and the abolishment or diminution of standing armies and the formation and increase of peace congresses."

In face of these explicit directions statutes have been drawn up, apparently with the sanction of the King of Sweden and others high in authority, providing that only sixty per cent. of the income need be used for the prizes and that they need be awarded only once in five years. The balance of the income—except perhaps in the case of the prize for the promotion of peace, regarding which information is lacking—is now used for the support of certain laboratories and libraries at Stockholm. These are doubtless needed, possibly more than the prizes established by Nobel, but they have been founded in dishonor. The clause establishing the laboratory of physics and chemistry is unpleasantly disingenuous. It says that it is to be "established primarily for the purpose of carrying out, where the respective Nobel committees shall deem requisite, scientific investigation as to the value of those discoveries in the

domains of physics and chemistry which shall have been proposed as meriting the award of Nobel prize to their authors. The institute shall, moreover, as far as its means allow, promote such researches in the domains of the sciences named as promise to result in salient advantage." The prizes have so far been awarded annually, but it is to be feared that when the money is needed in Sweden, it will be kept there in accordance with the provision of the statutes that when a prize is not awarded the money may be used for funds 'to promote the objects which the testator ultimately had in view in making his bequest in other ways than by means of prizes.'

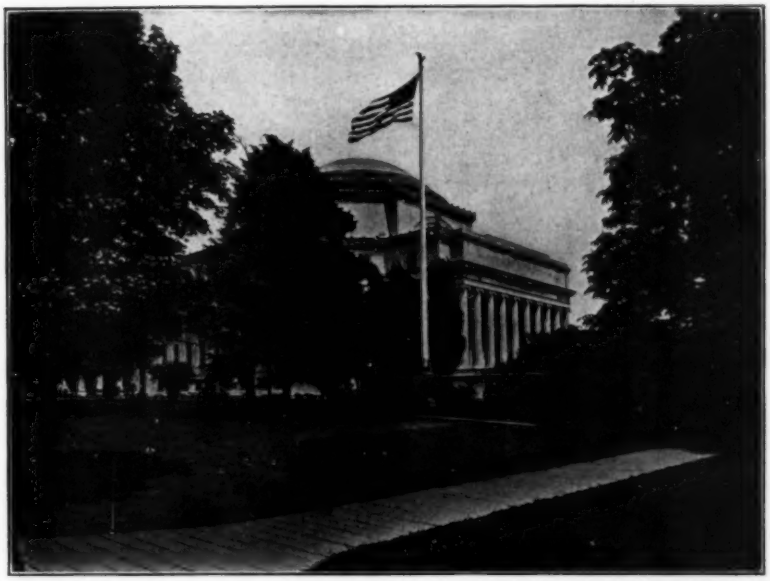
The administrators of the Nobel foundation have violated the conditions of the bequest in other ways which, though not so discreditable as the conveying of the money to local purposes and men, can not be regarded as justifiable. Nobel expressly stipulates that the prizes shall be awarded to those "who shall have contributed most materially to benefit mankind during the year immediately preceding." The statutes hedge, as follows: "By the proviso in the will to the effect that for the prize competition only such works or inventions shall be eligible as have appeared 'during the preceding year' is to be understood that a work or invention for which a reward under the terms of the will is contemplated shall set forth the most modern results of work being done in that of the departments, as defined in the will, to which it belongs; works or inventions of older standing to be taken into consideration only in case their importance has not previously been demonstrated."

In no single case has the award been made for work accomplished or published during the preceding year. The prizes have been given to men of eminence, most of whom accomplished their important work long ago. It would certainly be difficult to select each year the work most beneficial to mankind, and mistakes would undoubtedly be made; but the effort to make such a selection and to award the prize without regard to nationality, age or eminence would be a great stimulus to research, far greater probably than the methods adopted. But the question is not which method is the better, but for what purposes Nobel made his bequest. The terms of the will have also been violated by dividing the prizes and by awarding them to institutions, and its spirit has been especially ignored by giving the power of nomination and determination chiefly to Swedes. It does not of course follow that the dead hand should forever control. But Nobel died only ten years ago. He might be given his will for a little while at least, and under the special circumstances of the case it would seem only just to submit any provisions which proved impracticable or unwise to international consideration.

There is a certain lack of courtesy in thus criticizing actions sanctioned by the Swedish government and by those Swedish men of science at least who are accepting gratuities from the fund. Neither can we as a nation regard ourselves as fit to cast stones when we remember the histories of the Stewart, Tilden and other bequests, or when we consider that the Smithsonian Institution, established by a foreigner 'for the increase and diffusion of knowledge among men' has been used largely for the promotion of local interests. But it is only by frankly considering these things that we may learn that honor is more than great riches.

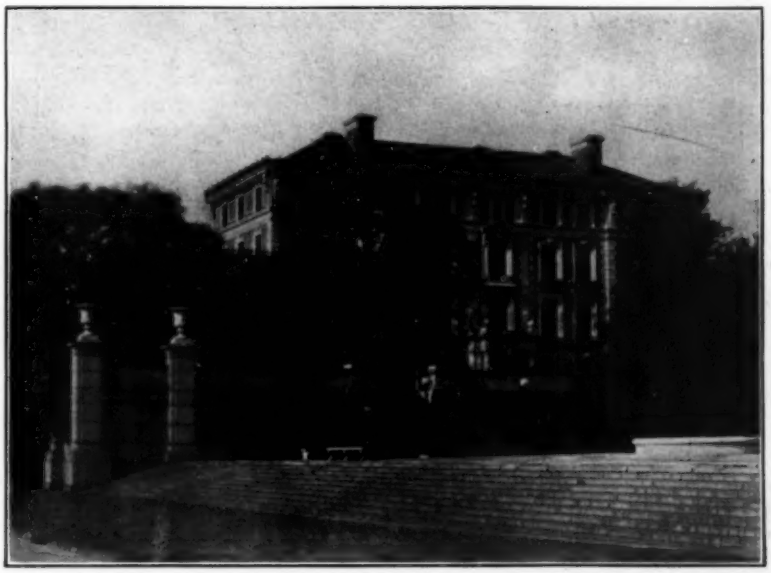
THE SCIENTIFIC MEETINGS OF CONVOCATION WEEK

THE American Association for the Advancement of Science and the national scientific societies affiliated with it hold their annual meeting this year in New York City, beginning on December 27. Washington and New York



THE LIBRARY OF COLUMBIA UNIVERSITY.

are now our two main scientific centers, there being in each city about five hundred men engaged in research work. The first of the convocation week meetings was held in Washington four years ago, with an attendance estimated at 1,500 members, and there is good reason to suppose that the present meeting will be even larger and more wide reaching in its effects on the



THE SCHOOL OF MINES, COLUMBIA UNIVERSITY. This building has just been completed. In the foreground is the house used by the Faculty Club.

EARL HALL, COLUMBIA UNIVERSITY. This building is the headquarters of the American Association and the affiliated societies.

advancement and diffusion of science.

It is not possible in this note to give a statement even of the main features of the programs. The American Association meets in ten sections, each with its own presiding officers and its program of papers and discussions lasting several days. There are further about twenty national societies which meet in affiliation, sometimes holding joint sessions with the sections of the association or with one another and sometimes meeting separately. These societies, which include those devoted to astronomy, physics, mathematics, chemistry, geology, geography, zoology, entomology, bacteriology, physiology, anatomy, botany, psychology, philosophy and anthropology, each has its independent organization and officers, so it is obvious that the programs are extensive. There will be at least five hundred papers read, which when published in detail will fill more than ten thousand pages.

The high character and broad interest of the proceedings may be briefly but adequately shown by a list of some of the retiring or presiding officers, most of whom will make addresses. Every one familiar with science in America will understand that they represent the best work now being accomplished. These officers include: Professor W. H. Welch of the Johns Hopkins University, Professor C. M. Woodward of Washington University, Professor William James of Harvard University, Professor Charles B. Davenport of the Cold Spring Biological Laboratory, Professor E. C. Pickering of the Harvard College Observatory, Professor Carl Barus of Brown University, Professor W. F. Osgood of Harvard University, Dr. W. F. Hillebrand of the U. S. Geological Survey, Mr. C. C. Adams of New York City, Professor W. E. Castle of Harvard University, Mr. A. H. Kirtland of Malden, Mass., Professor Erwin F. Smith of the U. S. Department of Agriculture, Professor W. H. Howell of the Johns Hopkins University, Professor Franklin P. Mall of the Johns Hopkins University, Dr. F. S. Earle of Herradura, Cuba, Professor J. R. Angell of the University of Chicago, Professor F. W. Putnam of Harvard University, Professor John F. Woodhull of Teachers' College, Columbia University, Professor Edward Kasner of Columbia University, Professor W. C. Sabine of Harvard University, Mr. Clifford Richardson of New York City, Mr. W. R. Warner of Cleveland, Ohio, Dr. A. C. Lane of the Michigan Geological Survey, Professor

Edwin G. Conklin of the University of Pennsylvania, Dr. D. T. MacDougal of the Carnegie Institution, Mr. Charles A. Conant of New York City, and Dr. Simon Flexner of the Rockefeller Institute for Medical Research.

Most of the meetings will be held at Columbia University, but there will also be sessions at the American Museum of Natural History, The Rockefeller Institute for Medical Research, the College of the City of New York, the New York Botanical Garden and elsewhere. These and other scientific institutions of the city have in recent years made extraordinary progress. There is here only space to show several of the buildings of Columbia University, which, having removed to its new site overlooking the city of New York only ten years ago, has now a group of academic buildings in many respects unequalled.

THE OPSONIC INDEX OF WRIGHT AND DOUGLAS

Sir Almroth E. Wright, M.D., F.R.S., pathologist to St. Mary's Hospital, London, and late professor of pathology, Army Medical School, Netley, delivered the third course of lectures on the Herter foundation in the Physiological Building of Johns Hopkins Medical School on October 8, 9 and 10, 1906. The subject chosen was 'The therapeutic inoculation of bacterial vaccines and its application in connection with the treatment of bacterial disease.' As this subject is an important elaboration of Metchnikoff's work upon phagocytosis and of Ehrlich's side-chain theory, it may not be out of place briefly to outline from these lectures Wright's method and to cite a few illustrative cases showing the value of this mode of procedure in the treatment of certain bacterial diseases by vaccines.

The term opsonin, meaning 'to prepare for a meal,' is given to a recently discovered and important constituent of both normal and immune sera, by means of which bacteria are prepared for phagocytosis. The method of determining the opsonic index is as follows: About five cubic centimeters of blood is withdrawn from a healthy person under aseptic conditions by pricking the finger. This blood is then placed in a glass tube (*A*), slightly heated to facilitate clotting, and centrifugalized so as to separate the serum from the clot. In a second tube (*B*) is placed about the same amount of blood, to which is added sodium-citrate solution in order to prevent clotting. By centrifugalizing this there are obtained three layers, *i. e.*, serum, white corpuscles and red corpuscles. The serum it pipetted off and the solution containing leucocytes at once becomes easily accessible. A third tube (*C*) contains an aqueous solution of tubercle bacilli. This is also centrifugalized in order to get a fine suspension. Equal quantities of the serum of a healthy person (*A*); of white blood corpuscles (*B*); and of a tubercle bacilli solution (*C*) are drawn into a capillary tube and freely mixed. They are then placed in an incubator for twenty minutes. A film is next made and stained by any of the well-known methods of staining for tubercle bacilli. Then the exact number of bacilli found to be present in thirty consecutive multinuclear leucocytes are counted by the aid of an oil-immersion lens—call it in this case *X*. The process is now repeated, substituting the blood of a patient for the blood of the healthy person, the white corpuscles and aqueous tubercle solution remaining constant in both estimations. The result obtained by counting these latter may be called *Y;* in that case the opsonic index of the patient's blood is expressed thus, *Y/X*, which is usually a decimal. The entire process occupies about one hour and a quarter in the hands of an experienced laboratory worker.

The surgeon's idea of curing bacterial diseases, such as scrofulous glands of the neck, seems too often to be that of extirpation, though he does often employ instead of the knife

various recent methods of treatment, such as Röntgen rays, Finsen's light, radium and Bier's passive hyperæmia. The ideal treatment, however, of bacterial disease is to put into the blood a substance, like an antiseptic, which will kill the bacteria or neutralize their toxines, but which will not injure the tissues with which it is brought in contact. This has been done to a certain extent by the antitoxin of diphtheria, but there has not been discovered, up to the present time, a scientific and exact method by means of which the therapeutic use of such agents as tuberculin could be controlled in order that the smallest amount of detriment possible might ensue to the patient during the course of the treatment. That there exists a certain substance in the serum of the blood which is capable of aiding phagocytosis, is shown by the history of a case cited by Wright in which there was a condition of furunculosis (boils) due to *staphylococci*. The patient's serum, his corpuscles and an emulsification of dead *staphylococci* gave a count of 26; while the patient's serum, the corpuscles from a normal person and the emulsion, gave 27; the normal serum, the normal corpuscles and the emulsion, gave 13; the normal serum, the patient's corpuscles and the emulsion also giving 13. This would show that the corpuscular elements had nothing to do with the increased number of *staphylococci* which were taken up by the leucocytes and would show that the property of increasing the number of *staphylococci* in the leucocytes is to be attributed to the so-called opsonin in the serum itself.

By using this index after the injection of the vaccine, it will be seen that there is usually a slight decrease in the opsonic index, followed by a marked secondary rise; though if the dose be too large or a second dose be administered too quickly, this secondary rise may not occur at all. The interesting fact was brought out by Wright in his lectures that a surgical operation, or even massage, or sitting up in bed, may cause a similar reaction in a tuberculous foci. The disadvantage of securing the reaction by these methods is that live tubercle bacilli may be introduced into the blood stream and that their lodgment and subsequent multiplication may take place. Dr. Wright is so sanguine of the success of this mode of treatment that he believes that every case of *localized* tuberculosis may be now cured by the *proper* use of the vaccines of tuberculosis.

SCIENTIFIC ITEMS

A MEETING to commemorate the life and service of Samuel Pierpont Langley, secretary of the Smithsonian Institution from 1887 to 1906, was held in the lecture room of the United States National Museum on December 3. The following addresses were delivered: 'Introductory Remarks,' by the chancellor of the Smithsonian Institution, the Honorable Melville W. Fuller, chief justice of the United States; 'Memorial on Behalf of the Board of Regents,' by the Honorable Andrew D. White, LL.D.; 'Mr. Langley's Contributions to Astronomy and Astrophysics,' by Professor E. C. Pickering, director of the Harvard College Observatory; 'Mr. Langley's Contributions to Aerodynamics,' by Octave Chanute, Esq., of Chicago.

DR. HENRY FAIRFIELD OSBORN, Da Costa professor of zoology in Columbia University, curator of vertebrate paleontology and vice-president of the American Museum of Natural History, geologist and paleontologist of the U. S. Geological Survey, has declined the secretaryship of the Smithsonian Institution to which he was elected by the regents on December 4.—Dr. Andrew Fleming West, professor of Latin at Princeton University and dean of the graduate school, has declined the offer of the executive committee of the Massachusetts Institute of Technology to nominate him for the presidency.